POWER PLANT ENGINEERING

Established Over 35 Years

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A la Mode

"MORE CAPACITY per dollar invested" sounds impressive when broadcast with appropriate figuring by utility engineers but it takes the boys from down in Alabam' to do things in a big way.

Outdoor setting, self opening smoke box, non-destructible gage glass, air cooled walls and simplified auxiliaries as demanded by the most advanced practice are utilized to advantage. Above is a recent 36-in. by 12-ft. h.r.t. boiler suspended front and rear from single loops on wooden gallows frames, with setting laid up in stone and mud.

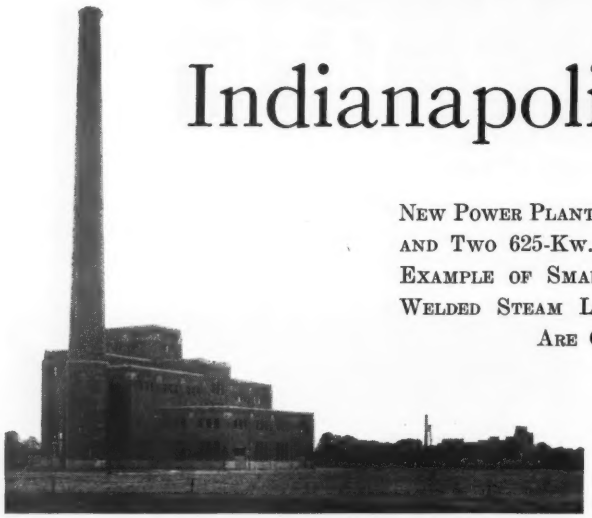
The formidable beam across the front is not a barrier to keep the natives from crawling through the fire doors; it's wired there to keep the smoke box door shut. The rear arch is made from a piece of sheet iron held down by rocks and the boiler is fed through the blowoff by an injector suspended in mid air as shown at the right hand side of the picture.

Safety? Oh, yes. The gage glass is nondestructible because there isn't any but then it's not needed. Note that one of the three try cocks on the water column works. The pointer on the steam gage is missing but the tail end of the needle remains on the spindle so that a good estimate of the pressure can be made. We don't know for sure but probably the safety valve was left in Birmingham so that it could be examined after the explosion.

Fuel costs nothing as they burn waste from the sawmill and the cost per horsepower of capacity must be low but, for some reason, W. W. Pettibone of the Fuel Efficiency Engineering Corp., Birmingham, who sent us the picture, modestly insists that it's not one of his designs. Sometimes, as Mr. Custer points out on page 647, it is necessary to be extremely careful how fast a boiler is cooled down but we wager that such a detail never bothers the fireman who operates this one.

Indianapolis City Hospital

NEW POWER PLANT WITH THREE 500-HP. 160-LB. BOILERS AND TWO 625-KW. NONCONDENSING TURBINES IS FINE EXAMPLE OF SMALL PLANT DESIGN. STEAM HEADER, WELDED STEAM LINES AND COAL HANDLING SYSTEM ARE OUTSTANDING FEATURES



ADDITIONAL BUILDINGS added to the City Hospital, Indianapolis, Ind., in 1930, made it imperative to increase facilities for supplying light, heat, refrigeration, water and power, for, with the exception of emergency light and water connections, the institution is an independent unit depending upon its own plant for these services. The existing power plant was old, had outlived its usefulness and was located on space needed for future hospital buildings. An entire new plant, located in the far corner of the property so as not to interfere with future construction, was decided upon.

This $530,000 plant, shown in the headpiece, was designed to meet four major requirements: continuity of service, an extremely important consideration in a hospital; flexibility to take care of future demands; standardization, to use only standard, proven equipment of first quality, easily replaceable; and accessibility, to enable efficient, reliable operation with a minimum of labor. The resulting plant is an excellent example of finished small plant design, and an outstanding example of coöperation between the consulting engineer, Charles R. Ammerman and the chief engineer, Charles A. Taylor. Although the importance of this coöperation is well recognized by central stations, it is sadly lacking in the industrial field where petty jealousies often interfere with development of a scheme to its logical conclusion.

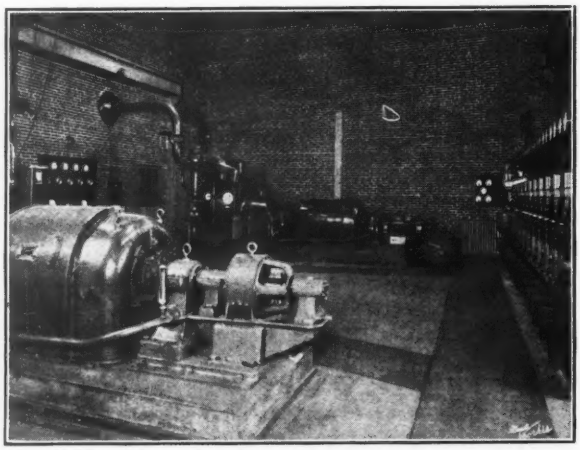


FIG. 1. THE TURBINE ROOM WITH TWO 625-KW. TURBINES. THE SWITCHBOARD IS ALONG THE RIGHT WALL.

In plan and section, the new plant is shown by Figs. 2 and 3 with three boilers and two turbines installed. Space is provided for two additional boilers and another turbine to the right of the temporary wall. At present this space is being used as a garage. The present plant as installed is of ample capacity to carry a further increase in load consisting of a 7-story, 2-wing ward building for which plans and specifications are already prepared, but for which construction work has not been started.

BOILERS AND TURBINES

Boilers are 500-hp., 160-lb. gage, 3 -pass Stirlings fired by six compartment 10 by 13-ft. Illinois forced draft chain grate stokers. Carrick combustion control is used and the stokers can be driven by Wachs steam engines or electric motors through Reeves transmission as desired. American Blower forced draft fans, one for each boiler and driven by steam engines through V-belt drives, are set in the basement with the ducts located as marked on Fig. 2. All boilers are connected by a common breeching to a 200-ft. radial brick stack. Westinghouse turbines receiving steam at 150 lb. discharge against a back pressure of 5 lb. gage, to the low pressure heating mains. They drive 3600-r.p.m. 780-kv-a., 80-per cent p.f., 480-v., 3-phase, 60-cycle generators and 13 kw., 125-v. shunt wound direct connected exciters.

Auxiliaries are located in the boiler room in a space which, in the finished plant, will be between the third and fourth boilers. In the basement are three steam driven vacuum pumps for the heating system; on the firing floor, two horizontal duplex boiler feed pumps and immediately above them on a gallery the Cochrane metering heater and feedwater strainers. As shown in the section, Fig. 3, the Cochrane hot process heater and condensate storage tank is on the level above the feedwater heater with the chemical tanks and sand filter on the gallery level. A water storage tank is provided in the coal tower for receiving water from turbine oil coolers, vacuum suction strainer and vapor economizer, from which it flows as required to the water softener.

The plant is connected with the hospital by a well lighted, well ventilated roomy tunnel carrying medium pressure (100 lb.) and low pressure (5 lb.) steam, compressed air, vacuum return and cold water lines. Water for the entire institution is supplied from two 320-ft. wells pumped by air lift from air compressors

located in the turbine room basement. The water is quite hard, running about 29 gr. per gal. The part used for boiler feed makeup is softened in the hot process softener in the power plant while treated water

frigerating plant with 5-ton ice plant and a battery of Frank hot water heaters are located at the hospital buildings. Steam for the heating system is largely from the turbine exhaust at 5 lb. gage, the balance being

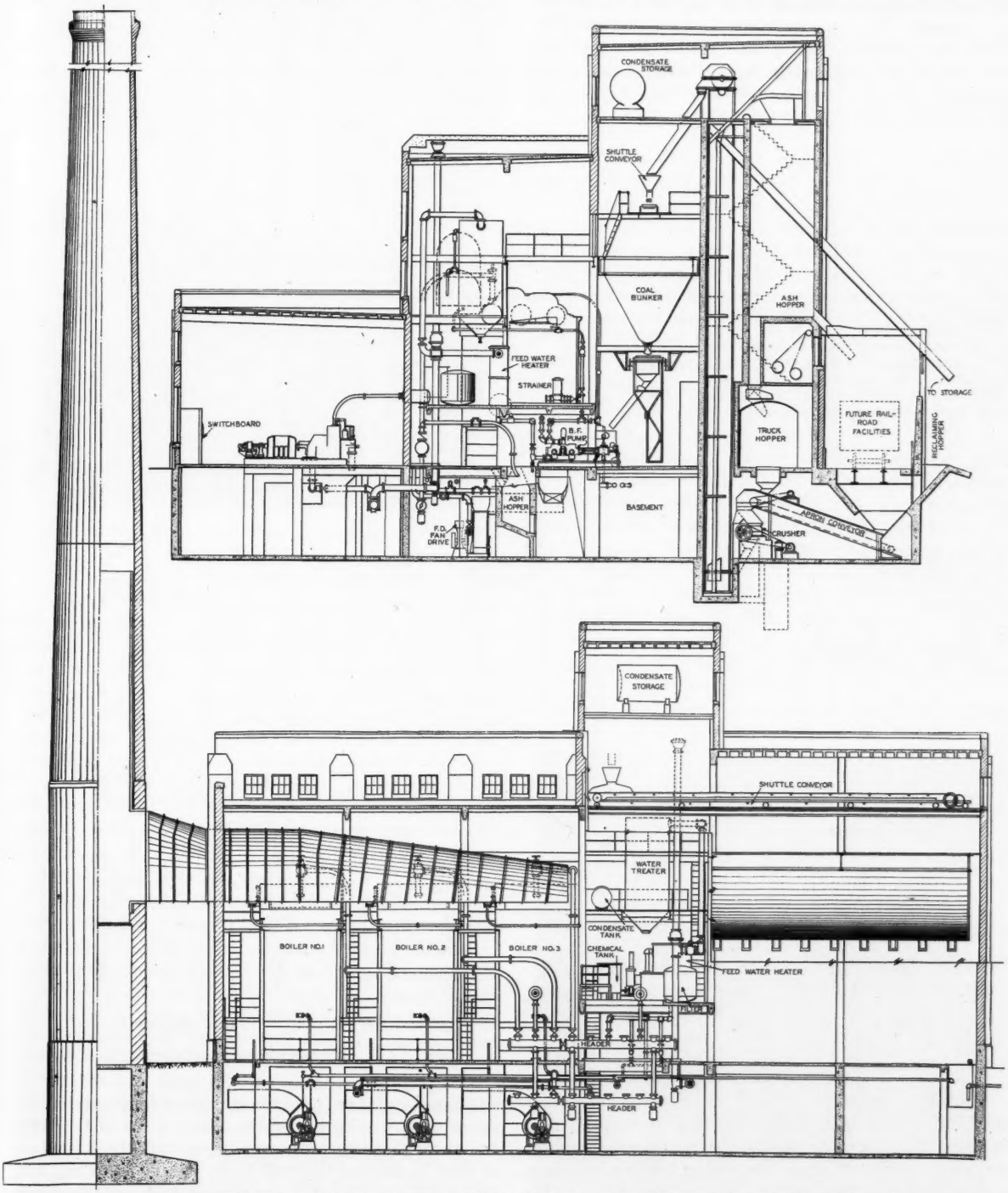


FIG. 2. CROSS SECTION OF THE INDIANAPOLIS CITY HOSPITAL POWER PLANT.

for the hospital is softened by zeolite softeners installed in the ice plant. The hospital is supplied with raw water, hot and cold treated water and distilled water in addition to power, lights, heat and ice.

A modern laundry, a 50-t. Carbondale absorption re-

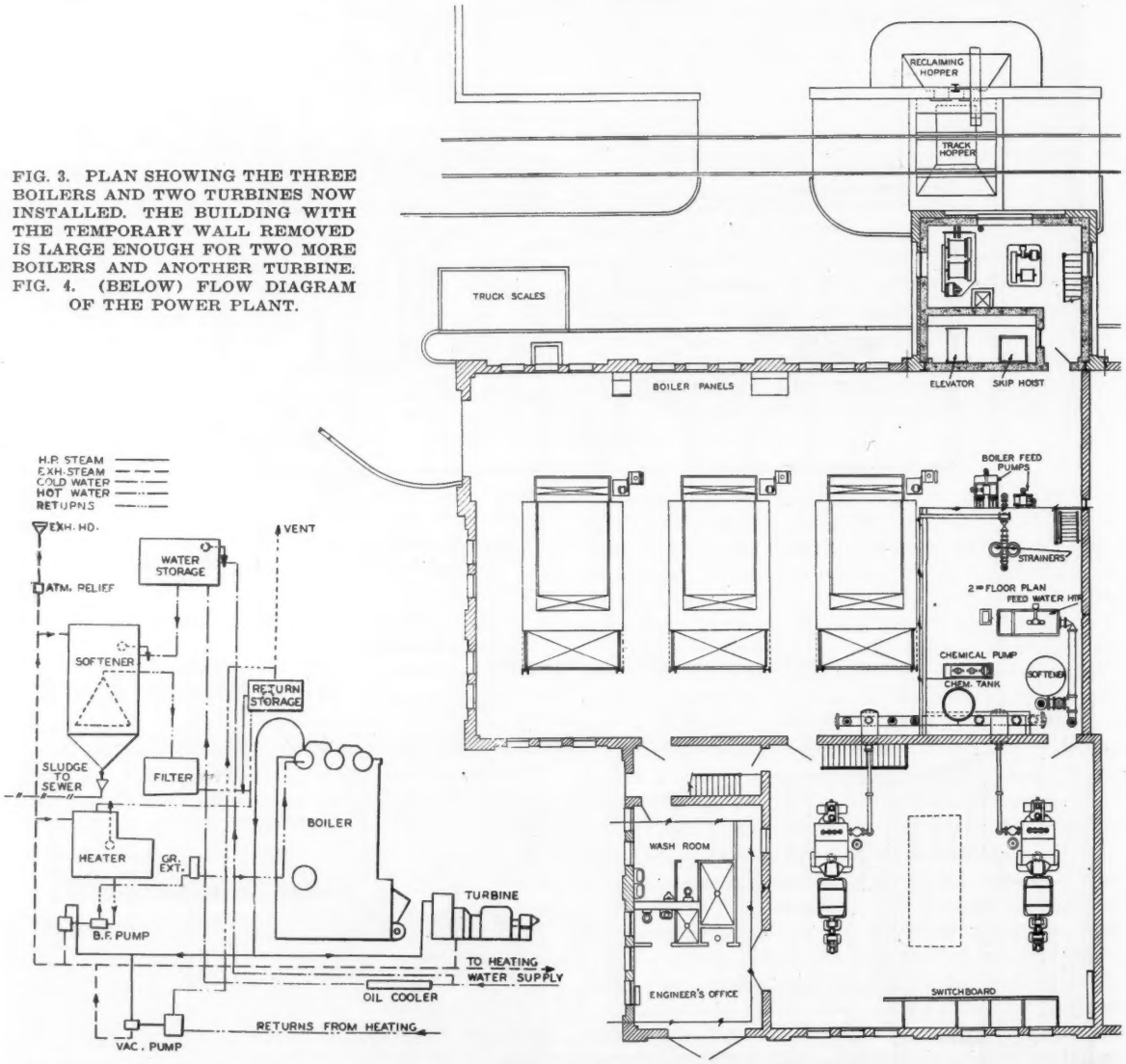
made up from live steam to the intermediate or 100-lb. pressure line and then through additional reducing valves to 5 lb. at the point needed.

The success of the new power plant is shown by the fact that allowing for the milder weather, additional

hospital requirements have increased the load 35 per cent over last year but since the start of the new plant this increased load was carried (for Jan. Feb. and Mar.) at a saving of $600 a month for coal. Fourth vein Indiana screenings running about 11,500 B.t.u. per lb. are burned. The approximate analysis is: volatile, 34.37; fixed carbon, 45.11; moisture, 11.23; ash, 9.29 per cent. Coal consumption for the months mentioned averaged about 31 t. per day and the electric load about 3400 kw-hr.

and unusual features which warrant special mention. The chief engineer's office, over the machine shop, overlooks the turbine room, instrument board and switchboard. The piping is all welded, using tube-turns and makes an exceptionally clean cut appearance. The steam header arrangement shown in Fig. 5 is unusual and is designed primarily to insure flexibility and complete separation of entrained moisture or water from the saturated steam. Both the upper and the lower header are sectionalized with one boiler tied into the

FIG. 3. PLAN SHOWING THE THREE BOILERS AND TWO TURBINES NOW INSTALLED. THE BUILDING WITH THE TEMPORARY WALL REMOVED IS LARGE ENOUGH FOR TWO MORE BOILERS AND ANOTHER TURBINE.
FIG. 4. (BELOW) FLOW DIAGRAM OF THE POWER PLANT.



Complete operation of the power plant, ice plant and heating system is carried on by a crew of 17 men, the operating crew in the power plant consisting of one chief engineer, three operating engineers, three firemen, one coal man and one boiler repair man. Administration, operating and maintenance budget for the entire institution coming under this division for the year is: labor, $22,240; coal, $25,000; salt, lime and soda, $1500; oil, $700; new equipment, $200; repairs and replacements, $3000.

Although standardization was one of the aims of the designers, the plant has a number of interesting

left-hand and two into the right-hand section of the upper one. The upper section drains down to the lower one through three cross-over pipes and the lower one in turn is drained through Cochrane dischargers. Turbine leads are from the upper manifold with Cochrane steam purifiers preceding each turbine. The auxiliary steam line loops around the basement from the left hand section of the upper to the right-hand section of the lower header insuring steam supply at all times. The 100-lb. makeup line is from the lower section and this small steam flow from the upper to the lower drum assists drainage.

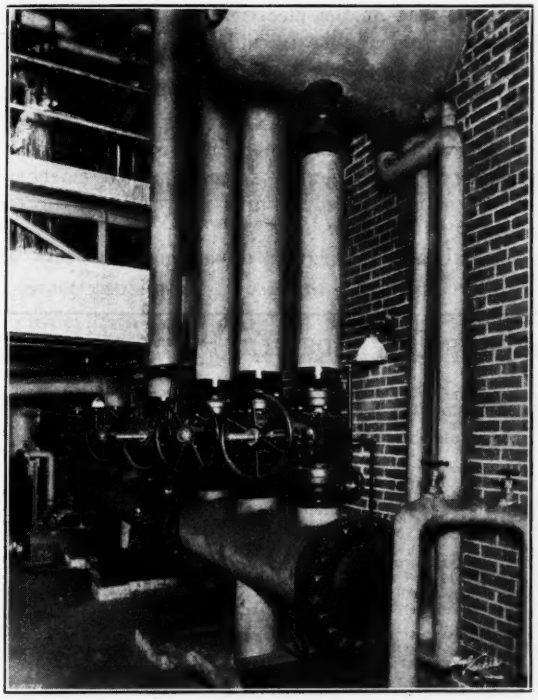


FIG. 5. THE STEAM HEADER DESERVES SPECIAL ATTENTION.

Coal handling facilities are unusually complete and well arranged. At present, coal is received by truck although it is probable that a spur track will be available later. For this reason, both a railroad and truck hopper have been incorporated so that only the rails need be added later for the railroad spur. Platform scales in the roadway (with the beam in the boiler room) make it possible to check coal weights. In case the coal handling facilities are not operating, the boiler room door and firing aisle are large enough to allow a truck to back in and dump the coal in front of the boilers.

In normal operation, however, the coal is taken from the track hopper by a Stephens-Adamson apron conveyor and after passing through a single coal crusher or bypass is picked up by a bucket elevator. The discharge of the bucket elevator can be split and sent either to the 500-t. overhead bunker or to the storage yard, where it can be stored by a Sauerman drag scraper. The operator can adjust the elevator discharge spout from the lower end of the elevator and the drag scraper is operated from a room on the second floor of the coal tower, from which the operator has a clear view of the yard.

On the way to the storage bunker, the coal falls on a 60 ft. shuttle conveyor, Fig. 4, which operates in either direction and which can be moved to discharge to any part of the 126 ft. long bunker without the use of a tripper. From the bunker, coal is distributed to the stoker hoppers by a Stephens-Adamson 2000-lb. motor driven weigh larry shown in Fig. 6. In addition to the motor drive, the larry is equipped with a hand chain which would enable the operator to fill the hoppers by hand if power were not available.

By means of an interlocking control, the entire coal handling system can be started up from a point near the feeders but individual push button control near each drive makes it possible to start up or stop each unit independently.

From the hoppers, shown in the section, Fig. 2, ash is raked out into buggies and transferred to a 30-cu.ft. Stephens-Adamson skip hoist which elevates it to an 11-ft. square concrete hopper in the coal tower.

The main switchboard controlling the entire system consists of 15 panels and sub panels and is of the manual remote control type. The generator operating section of the board consisting of the usual field and exciter switches, circuit breakers, indicating and integrating instruments for complete control of each of the present generators as well as a blank panel with all exciter and other connections for the installation of a larger turbine unit. A regular panel was provided equipped with a standard vibrating reed type of voltage regulator, which meets the requirements of steady voltage for X-ray operating and therapeutic uses.

Totalizing panel consists of the necessary indicating graphic recording and integrating instruments showing total output of the plant. The remaining panels of the switchboard are for the control of the 480-v. primary feeders, each building having a separate primary feeder and panel equipped with circuit breaker, overload protection, indicating and integrating instruments. As an auxiliary source of supply for the surgery as well as emergency lighting, a Utility 480-v. service controlled through interlocking circuit breakers was installed.

All switch gear buses, station transformers, and

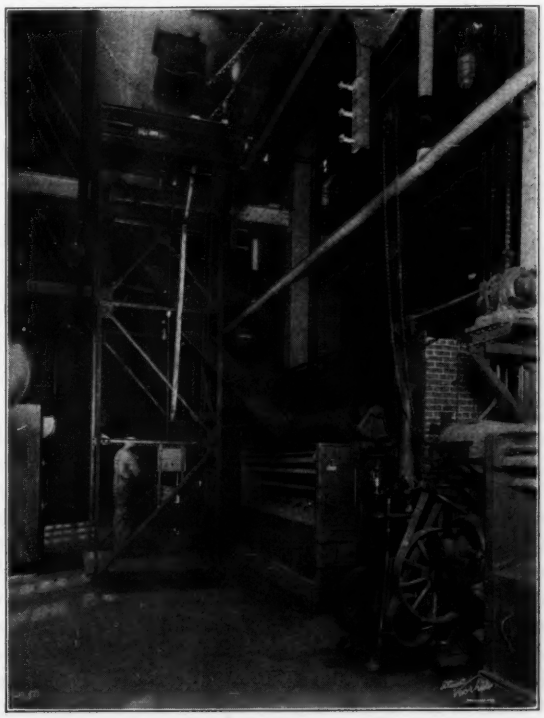


FIG. 6. THE FIRING AISLE WITH THE WEIGH LARRY.

similar equipment are in a fire proof room directly below and manually remote controlled by operating rods from, the switchboard on the turbine room floor. Each primary feeder circuit is installed in a conduit at the top of each tunnel in a space reserved for electrical distribution and to meet the requirements of future extension special junction boxes are installed at locations for the proper pulling of the cables and feeders for future buildings. Each primary feeder circuit terminates at a transformer vault in each building where step down transformers are installed for lighting. Electricity is distributed three-phase, four-wire 120/208 v. to lighting panels on each floor. Where large quantities of power were required as in the laundry, and for water pumps or fans, they are fed directly from the primary feeders through distribution panels to the motors.

Building of the new power plant tunnels and utility distributing systems presented several problems of major importance, due to the fact that all of the buildings of the group constitute an emergency hospital and all service utilities had to be maintained to meet emergencies at all times. Seven of the old buildings were served with heat, water, light, power and refrigeration from the old power, which supplied 125 v. 2 wire d.c. for light and power. In all cases all of the systems were interconnected and changed over from the old to the new plant without interruption of service.

In the case of the electrical distribution, all secondary service mains in old buildings were reinstalled for 3-ph., four-wire distribution to new distributing panels utilizing the present cabinets and two-wire branch circuits. Corridors, stairs, exit passages, operating rooms, emergency rooms, and X-ray were rewired and served from separate emergency lighting primary feeders and transformers in each building.

Special X-ray surgical apparatus, elevators and power equipment were converted from direct to alternating current by providing new power circuits and motors on the equipment or the use of special designed motor generator sets. Doctor's Recorders, Paging, Patient's Signals as well as the group fire alarm system, which has a direct connection with the city fire alarm system at each firm alarm box, were maintained in constant use during the change-over of the two plants, redesigning the source of supply as required to adapt to the new system.

Principal Equipment in Indianapolis City Hospital Plant

Boiler Room

3 Babcock & Wilcox Co. 500-hp., 160-lb. Stirling boilers.
3 Illinois Stoker Co., 10 by 13-ft. traveling grate forced draft stokers driven by Wachs engine or G.E. 3-hp. electric motors for standby through Reeves transmission.
3 Hays Corp. boiler panels consisting of a Cochrane flowmeter, a Hays 10-pointer draft gage, flue gas and CO_2 recorder. The 10-pointer draft gage indicates fan pressure, 1, 2, 3, 4, 5 and 6th stoker compartments, over fire, second pass and last pass draft.
3 American Blower Co. size 7 Sirocco forced draft fans driven by 6 by 6 Type A steam engines through V-belt drives.
6 Crane Co. 4-in. safety valves 2 per boiler, capacity each 25,050 lb. per hr. 6 lb. blowdown.
3 Elliott Co. Class AA No. 1 Lagonda automatic cutoff valves.
1 Alphons Custodis Chimney Construction Co., 200-ft. radial brick chimney.

Blowoff valves.....A. W. Cadman Mfg. Co.
Blowoff cocks....Barrett Machine Co.
Combustion control.....Carrick Engineering Co.
Feedwater regulators, Copes.....Northern Equipment Co.
Soot blowers.....Diamond Power Specialty Corp.
Water columns and gage glasses..Reliance Gauge Column Co.
Valves .....Consolidated Ashcroft Hancock Co., Inc.
.....Lunkenheimer Co.
.....Walworth Co.
Pipe .....
Pipe Bends.....Tube Turns, Inc.

Traps and drainers	Boylston Steam Spec. Co. Cochrane Corp. Crane Co. Warren Webster & Co.
Reducing Valves	Boylston Steam Spec. Co. Foster Eng'r'g Co.
Indicating gages and meters	Bristol Co. Consolidated Ashcroft Hancock Co., Inc. Crosby Steam Gage & Valve Co.
Steam flowmeters	Bailey Meter Co. Cochrane Corp.
Recording Thermometers	Bristol Co.

Turbine Room

2 Westinghouse Elec. & Mfg. Co. 780-kv-a., 480-v., 3-phase, 60-cycle, 80 per cent p.f. 3600-r.p.m. turbo generators, throttle steam 150 lb. per sq. in., 5 lb. backpressure. Each with a direct connected 13-kw., 125-v., shunt wound, direct connected exciter.
2 Cochrane Corp. 6-in. live steam purifiers, one on each turbine line.
1 General Elec. Co. 15-panel switchboard installed by the Sanborn Elec. Co.
1 Pennsylvania Pump & Compressor Co. 12 by 12 by 12 in., 125 lb. air, 150 lb. steam, air compressor, normal speed 250 r.p.m., with a Jarecki governor.
1 Gardner Denver Co. 8 by 8 by 8-in., 75 lb. air compressor.

Atmospheric relief valves.....Cochrane Corp.

1 Industrial Brownhoist Corp. turbine room hoist with a Yale & Towne 10-t. block.

Water and Coal Handling

1 Dean Bros. Co. 12 by 8 by 18-in. outside center packed boiler feed pump.
1 Dean Bros. Co. 12 by 8 by 12-in. outside center packed boiler feed pump with Hills-McCanna lubricator and Copes pump governor.
1 Dean Bros. Co. 18 by 20 by 24-in. simplex vacuum pump with Hills-McCanna lubricator and Warren Webster governor.
1 American Steam Pump Co. 8 by 10 by 12-in. simplex vacuum pump with Hills-McCanna lubricator and Warren Webster governor.
1 Dean Bros. Co. 10 by 12 by 12-in. simplex vacuum pump with Hills-McCanna lubricator and Warren Webster governor.
1 Cochrane Corp. deaerating metering heater, capacity 90,000 lb. per hr.
1 Elliott Co. Lagonda twin grease extractor.
1 Cochrane Corp. 60-sq. ft. heater vent condenser.
1 Cochrane Corp. type QS, 4000-lb. per hr. hot process water softener. Installed by the I. C. DeHaven Eng. Co.
2 Stephens-Adamson Mfg. Co. steel receiving hoppers under concrete track hoppers.
1 Stephens-Adamson Mfg. Co. 30 in. wide, 20 ft. 3½ in. centers, overlapping pan conveyor. Driven at a variable speed of 20 to 120 f.p.m. by a 3-hp., 870-r.p.m. Westinghouse motor through a Stephens-Adamson JFS variable speed reducer.
1 Stephens-Adamson Mfg. Co. 16 by 8-in. bucket elevator on 84 ft. centers. Driven at 260 f.p.m. by a 10-hp., 440-v. Westinghouse motor.
1 Jeffrey Mfg. Co. 18 by 18-in. single roll crusher driven by a 10-hp. 1200 r.p.m. 440-v. induction motor.
1 Stephens-Adamson Mfg. Co. 18 in. wide, 60 ft. centers shuttle belt, belt conveyor. Belt speed 260 f.p.m. in either direction and driven by a 3-hp. 440-v. 1160-r.p.m. reversible motor. Can discharge to any point over the 126 ft. long bunker without the use of tripper.
24 Stephens-Adamson Mfg. Co. Simplex quadrant cutoff gates on coal bunker.
1 500-t. coal bunker.
1 Stephens-Adamson Mfg. Co. 2,000 lb. motor-driven weigh larry.
1 Stephens-Adamson Mfg. Co. 30 cu. ft. skip hoist for ashes. Bucket speed 159 f.p.m. driven by a 15-hp. 900 r.p.m. 440-v. induction motor.
1 Sauerman Bros. ½-yd. drag scraper.

Sump pumps.....Chicago Pump Co.
Coal scale.....Standard Scale & Supply Corp.

Construction Contracts

Building.....Wm. P. Jungclaus Co.
Steam piping.....Freyn Bros.
Plumbing and water..R. M. Cotton Co.
Electric wiring..Sanborn Electric Co.

To anyone interested in making a trip through Russia for study of social and economic conditions, opportunity is offered by 30-day tours, Berlin to Berlin, July 15 and July 25, to be conducted by Roy H. Mackay, Fayerweather Hall, Columbia University, New York, N. Y. Professor Mackay, who is an economist and an authority on Soviet affairs, is arranging for conferences with Soviet officials, American engineers and builders. Those interested should write him direct.

Hoover Dam Will Provide 1,000,000 Hp.

Great project of Bureau of Reclamation includes dam 730 ft. high at Black Canyon on Colorado River, power plant, diversion and water control works and many other features

FOLLOWING the awarding of the contract for construction of the Hoover Dam on the Colorado River to Six Companies, Inc., on the basis of its low bid of $48,890,999, preliminary work on this development has begun. This organization is made up of the Utah Construction Co., Henry J. Kaiser & W. A. Bechtel, McDonald & Kahn, Morrison-Knudson Co., J. F. Shea Co., and Pacific Bridge Co. F. T. Crowe, manager of Six Companies, Inc., was for many years construction engineer for the Bureau of Reclamation. Elwood Mead is Commissioner of the Bureau of Reclamation, Raymond T. Walter is chief engineer for the Bureau and Walker R. Young is resident engineer of the dam.

Hoover Dam is considered the most important construction job ever undertaken by the Bureau. In one contract are included the dam, 730 ft. high, the 1,000,000-hp. power plant and appurtenant works. An All-American canal will carry the stored water to irrigators in Imperial Valley. The dam is in Black Canyon on the Colorado River, about 20 mi. downstream from Boulder Canyon and about 25 mi. southeast of Las Vegas, Nev.

Railroad and roads for transportation of material and a new town planned by S. R. DeBoer at Boulder City, 5 mi. from the dam site, to provide healthful living conditions for the working force, are important features of the development.

Works for diversion of the river during constructions, which will be built first, consist of upper and lower cofferdams and four diversion tunnels. The upstream cofferdam will be of the earth and rock-fill type. The downstream cofferdam will also be of the earth and rock-fill type, the downstream slope being protected from eddy action by a rock barrier. After the downstream cofferdam and rock barrier have serve their purposes they will be removed from the river channel by the contractor.

Four diversion tunnels, two on each side of the river, circular in section, lined with a minimum of 2 ft. of concrete, measure 50 ft. in diameter inside of the lining. In length the four tunnels average about 4000 ft. They will require 1,563,000 cu.yd. of tunnel excavation, as well as an additional 400,000 cu. yd. of open-cut rock excavation and the placing of 337,000 cu. yd. of concrete in the inlet and outlet structures and linings. Plugs in the tunnels will require 121,000 cu. yd. of concrete.

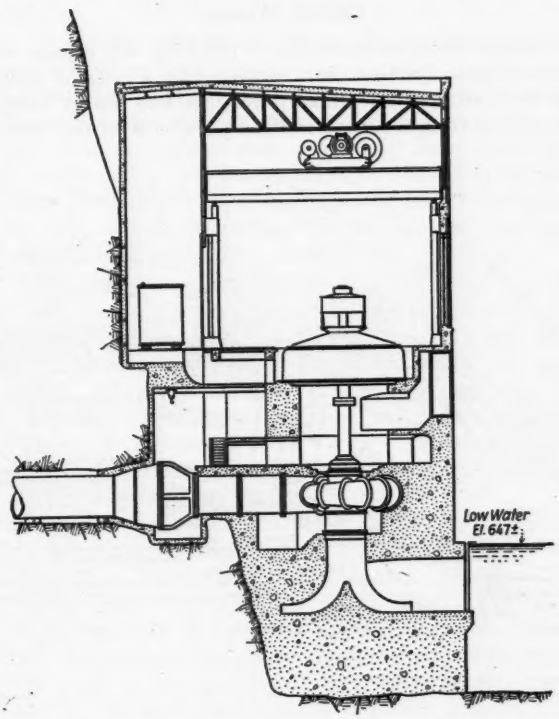


FIG. 1. CROSS-SECTION OF POWERHOUSE AT HOOVER DAM

The dam will be of the massive concrete arch-gravity type. It will be about 1180 ft. long on the crest and about 730 ft. in height above the lowest point of foundation bedrock. Radius of curvature of the axis will be about 500 ft. About 3,400,000 cu. yd. of concrete will be placed in the dam out of a 4,400,000 total for all the works. A cutoff trench will be excavated in the foundation rock along the upstream toe. The dam will contain a complete drainage system, with a main drainage gallery parallel to the axis of the dam, connecting with radial drainage conduits discharging at the downstream toe of the dam. To provide for expansion and contraction the concrete will be built up in sections or columns.

Setting heat of the concrete will be dissipated by means of a refrigeration plant supplying and forcing cooled water through pipes imbedded in the concrete. In addition to the drainage galleries there will be a number of inspection galleries. Two elevator shafts will connect the two wings of the power house with the top of the dam.

Spillways

Two spillways will be constructed, one on each side of the river. Each of these will consist, in downstream order, of a 50-ft. by 50-ft. Stoney gate, a concrete ogee overflow crest about 700 ft. long, a reënforced concrete-lined open channel, a 50-ft. diameter concrete-lined inclined tunnel, through which the water will pass into

the outer diversion tunnel. This outer tunnel, after having served its purpose as a diversion tunnel, will be plugged with concrete immediately upstream from its junction with the inclined spillway tunnel and the downstream portion will then become a part of the spillway system. It is estimated that the spillways will require 1,012,000 cu. yd. of open-cut excavation and 144,000 cu. yd. of excavation in the inclined tunnels.

Outlet Works

Outlet works on each side of the river will consist of two separate systems, each regulated by a cylinder gate in the bottom of an intake tower, the two towers being about 185 ft. apart in a direction parallel with the river. The system regulated from the upstream intake tower will consist, in downstream order, of the tower with a cylinder gate 31 ft. in diameter, discharging into a 30-ft. diameter inclined tunnel connecting with the inner diversion tunnel; the upstream tunnel plug in the diversion tunnel with temporary slide gates; the inner diversion tunnel below the upstream tunnel plug; the downstream lower and upper canyon-wall outlet gates and needle valves; the downstream tunnel plug with outlet gates and needle valves; installed therein; and the 50-ft. by 50-ft. Stoney gates at the outlet end of the inner diversion tunnels.

The system regulated from the downstream intake tower will consist of the tower with its cylinder gates 31 ft. in diameter discharging into a 30-ft. diameter horizontal penstock tunnel, leading to the upstream lower and upper canyon-wall outlet gates and needle valves. Power penstocks divert from each system. The lower and upper canyon-wall outlet gates and needle valves on each side of the river are housed in separate buildings. In each of the four buildings will be eight 72-in. needle valves for discharge control.

Power Plant

The power plant, immediately downstream from the dam, will be a U-shaped structure of concrete and structural steel with one wing on each side of the river, with the connection portion constructed across the downstream toe of the dam. Each wing of the building will be built sufficiently large to accommodate at least six and possibly eight, main power generating units, together with transformers, switching and control equipment, and auxiliary apparatus to generate a total of about 1,000,000 hp.

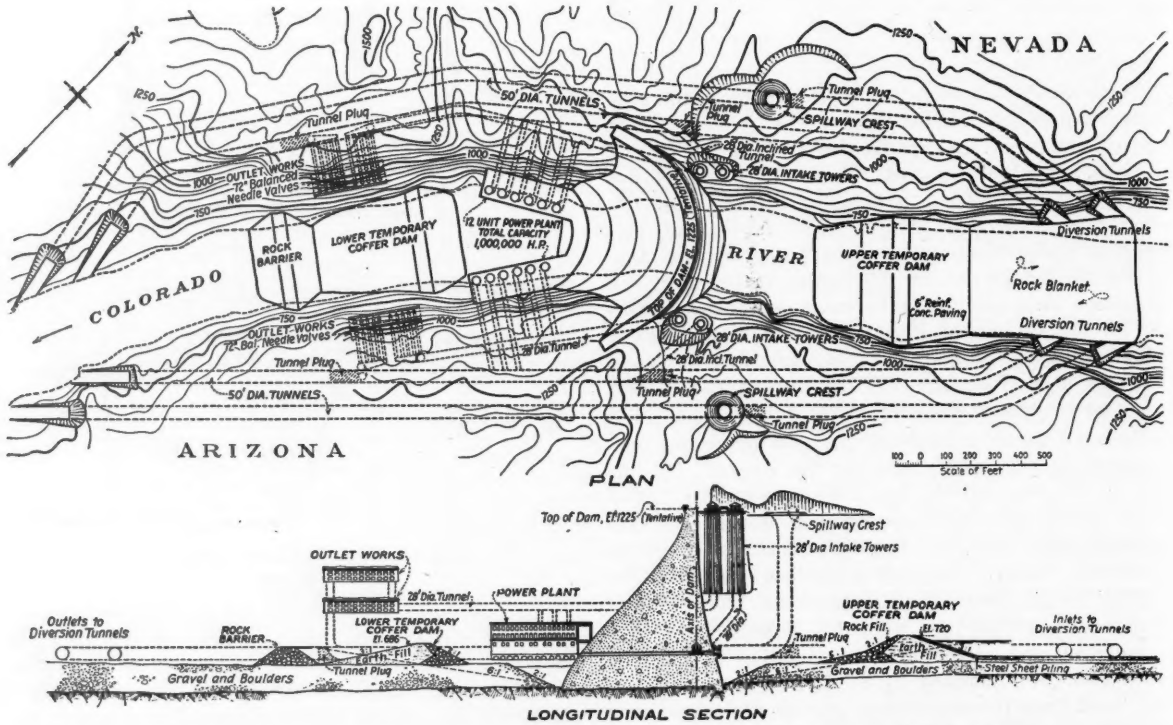


FIG. 2. GENERAL PLAN AND SECTION OF HOOVER DAM, SHOWING COFFER DAMS AND DIVERSION TUNNELS

Construction of the power house is covered by the specifications, but the hydraulic and electrical machinery, equipment and wiring will be installed by the Government.

The inclined freight elevator guide structure, on the slope of the canyon wall immediately downstream from the power house on the Nevada side of the river, will consist of a channel excavated in the rock wall and lined with concrete, in which track rails, structural guides and other metal work will be installed to guide the elevator car. This guide structure will be connected to the power house by a spur track constructed in a concrete foundation. The inclined elevator and spur track will be used by the Government for general operation and maintenance purposes. The distance between upper and lower landings will be 594 ft., the speed of the transfer car 60 ft. per minute, and the size of the car platform 12 ft. by 50 ft. The elevator may be used by the contractor during the construction period for transporting labor, materials, equipment and supplies.

The contractor and his subcontractors will be required to give preference at the time of employment, so far as practicable, first, to qualified ex-service men and second to qualified citizens of the United States.

Construction Program

The program outlined calls for completion of the four diversion tunnels by October 1, 1933, and the cofferdams by May 1, 1934. It is thought that placing of mass concrete in the dam will start not later than December 1, 1934. The program contemplates that all concrete, the construction of all necessary features for the beginning of storage of water by June 15, 1936, and of all other necessary features for the generation of power by September 1, 1936, with the storage of water to elevation 935, will be completed by the required dates.

Material Furnished

As a general rule, the Government will furnish to the contractor all materials which are to enter into the completed work. These include the more important items of cement, reënforcement steel, pipe and fittings, plate-steel conduit linings, gates and hoists, needle valves, power house machinery and structural steel. These materials will be purchased by the Government from time to time during the construction period, as they are needed. The contractor must furnish sand, broken rock or gravel and cobbles for concrete, form materials and lumber. Sand, gravel and cobbles will be obtained by the contractor from deposits on Government property, on the Arizona side of the river about 8 mi. upstream from the dam site.

A highway will connect with the end of the 7-mi. construction highway from Boulder City to the dam site and descend to the crest of the dam on the Nevada side of the river. After crossing over the canyon to the Arizona side on the roadway along the crest of the dam, the highway grade will rise to a terminus above the canyon rim, where it can connect with a contemplated State highway from Kingman. There will be constructed by the contractor about 4000 ft. of highway on the Nevada side and 1400 ft. on the Arizona side.

The construction railroad from Bracken Junction on the Los Angeles & Salt Lake Railroad of the Union Pacific system to the dam site will be completed about September 1, 1931. The United States section of 10¼ mi. from the summit, near Boulder City, to the dam site will be turned over to the contractor for the dam, power plant and appurtenant works, to be operated and maintained by him during the construction period.

Early Development of Power

It is expected that four units of the power plant will be placed in operation about 1 yr. and 8 mo. prior to the completion of the dam, and two additional units about 1 yr. later, all of these units to be operated by the downstream intake towers. In this connection, the Government reserves the right to commence the generation of power at any time after water has been stored to elevation 900.

Aluminum, bronze and brass castings with high zinc content cannot be welded successfully because the zinc vaporizes at comparatively low temperatures and forms gas which makes the weld porous.

Cost of Soot Blowing Operation

SOOT BLOWING EQUIPMENT for two 1500-hp. boiler units of the Youngstown Sheet & Tube Co. shows low maintenance costs and a considerable fuel and labor saving over hand lances as determined by a survey made by the engineers of the A. C. Nielsen Co. in collaboration with R. M. Smith, general boiler house foreman, Youngstown Sheet & Tube Co., Youngstown, Ohio.

Operating costs on the Diamond soot blowers averaged $1.16 per boiler horsepower per year. In comparison with the ordinary hand lance soot removal method, the mechanical blowers show a direct saving, that is fixed charges, maintenance, steam and labor of $476.65 annually and a fuel saving calculated at $1,904.64 per boiler. This gives a total savings of $2,381.29 per boiler per year, or approximately 50 per cent of the total installed cost per boiler of $4,707.00.

Equipment tested is in No. 8 boiler house and includes two identical 1500-hp. Springfield boilers used regularly to supply steam to the rod and wire mill. Both boilers are on the line for 24 hr. a day, 320 days a year, delivering steam at 175 lb. gage, 140 deg. F. superheat. Boiler rating averages about 150 per cent with an evaporation of about 8.4 lb. of water per lb. of coal. Both units are fired by Taylor 14-retort underfeed stokers.

Twenty-two soot blowers are installed on each boiler: five elements are the 30-jet, 15 the 29-jet and two the 28-jet type. Nozzles are spaced so as to direct one jet between each two vertical rows of tubes. The tubes are in two decks, 58 tubes wide and 8 tubes high. Four pairs of blower elements are located in the first pass; four pairs in the second pass and the remaining three pairs in the third pass, close to the front header.

Soot blowing is done once on each shift, the operation requiring 20 min. of one man's time. Steam actually flows from each of the 22 elements for about 30 sec. per blow. The flow averages about 170 lb. per min., three regular blows requiring about 7650 lb. of steam and one hour labor per boiler per day. In the test, changes of flue gas temperature were used as a measure of the soot accumulation on the boiler tubes. Soot blowing operation was suspended for 45 hr. after which the 22 blower elements were operated for a half minute, the entire operation requiring a little over 11 minutes' time. During this period, the flue gas temperature dropped from 550 to 495 deg. F., a change of 55 deg. or approximately 10 per cent.

At the same time two men with hand lances worked on the other boiler for 1¼ hr. At the end of that time they succeeded in lowering the flue gas temperature from 555 to 545 deg. F., a change of about 10 deg. or approximately 1.8 per cent. This manual operation was followed by a half of a minute operation with soot blowers and in less than 15 minutes the temperature dropped from 545 deg. where the men had left it to 500 deg. F.

Based on an annual consumption of 30,720 t. of coal in each boiler at a cost of $3.10 per t. in the bunkers, the annual savings are calculated to be $1,904.64. Cost of maintenance, labor, steam and depreciation costs, resulted in the figures given at the beginning of this article.

Compound Turbines for Auxiliary Drive

DETAILS OF STURTEVANT LJUNGSTROM COMPOUND TURBINES WHICH DRIVE THE FORCED AND INDUCED DRAFT FANS ON THE NEW HELL GATE BOILER UNITS

OF RECENT YEARS auxiliary drive practice has favored the electric motor largely because of the higher operating economy which could be expected. This has not been universal practice, however, and the forced and induced fan drives with the new Hell Gate boilers* should do much to bring the advantages of steam drive again before engineers. Steam consumption was an important consideration and compound turbines were selected as the most consistent with economy at the desired speeds.

The two new boilers have a nominal rating of 800,000 lb. of steam per hour each and each unit has four 125,000 c.f.m. (17 in. static pressure) induced draft fans, two 150,000 c.f.m. (11.5 in. static pressure) forced draft fans and two 1367-hp. compound turbines. Each 393-hp. low-pressure element drives, through gears, one of the forced draft fans and each 974-hp. element drives (also through gears) two induced draft fans.

High-pressure turbines receive steam at 265 lb. gage, 725 deg. F., and exhaust (normally) at 75 lb. gage. The low-pressure elements take steam at 75 lb. pressure and exhaust at a variable back pressure of 5 to 25 lb. to a closed heater located on the fan floor. The high-pressure element, low-pressure element, high-pressure rotor and turbine casing and flexible quill shaft are shown by Fig. 1.

Steam to the high-pressure element is regulated by the automatic control according to the load conditions. This steam is controlled by six cam-operated poppet valves which admit steam to six groups of admission nozzles. Any change in the steam flow affects the high and low-pressure turbine in about the same proportion.

*See Ljungstrom Turbine Fan Drives at Hell Gate, by W. E. Caldwell, p. 396, April 1, 1931 issue for the general arrangement of boilers, turbines and fans.

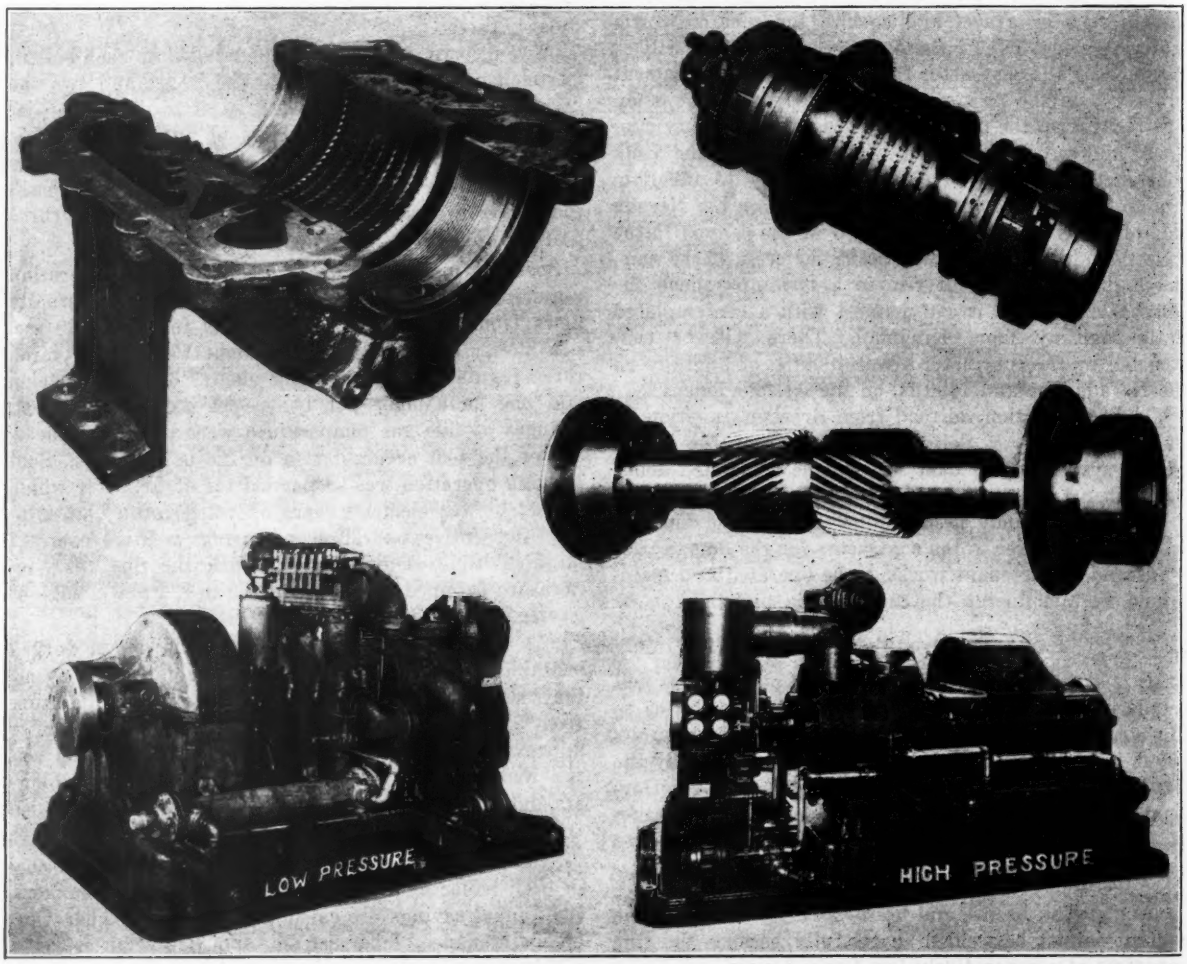


FIG. 1. VIEWS OF THE HIGH AND LOW-PRESSURE TURBINE AND THE HIGH-PRESSURE ROTOR, CASING AND QUILL SHAFT WITH UNDERCUT GEAR TEETH

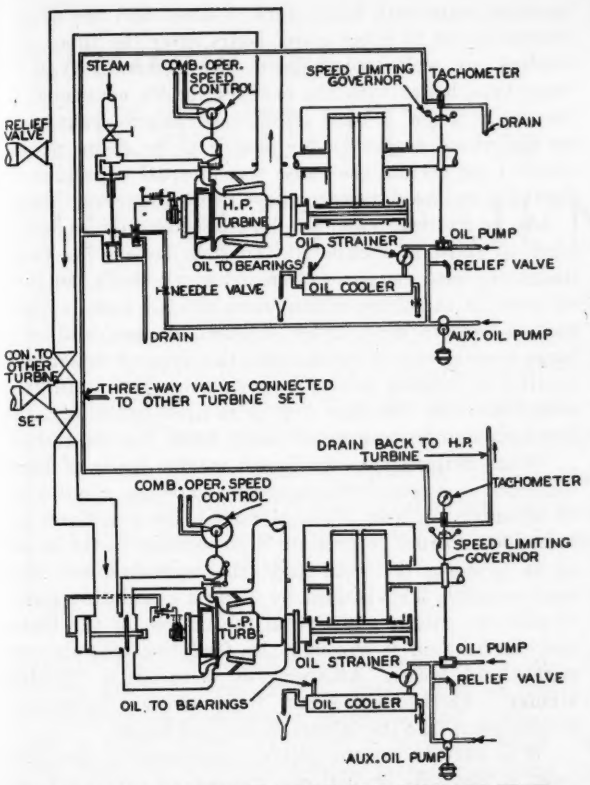


FIG. 2. CONTROL DIAGRAM OF ONE TURBINE UNIT

One third of the total inlet nozzles of the low-pressure element are also controlled by six cam-operated valves. These valves are visible in the photograph on the low-pressure turbine. These nozzles are operated by the combustion control and are regulated by the furnace pressure to control the receiver or cross over pressure, changing the relative heat drops through the high and low-pressure turbines. This distribution of work between the two elements is instrumental in giving good economy even at low loads and slow speeds.

As can be seen from the photograph, the rotors have one Rateau stage at the inlet followed by several stages of reaction blading. Reduction gears have undercut teeth, clearly shown in the pinion photograph, to provide flexibility and uniform tooth load distribution. Flexibility between the turbine and pinion is provided by a quill drive, that is, a flexible driving shaft extending through the hollow pinion shaft and connected at the far end to a flexible disc as shown.

Control and steam supply to these units is shown diagrammatically by Fig. 2. Turbine units are connected at the cross over pressure but in normal operation the sectionalizing valve will be kept closed so as to operate each set as a unit. By opening the valve, the turbines may be operated in any desired combination to give greater flexibility than would be possible with independent turbines on each fan. Fans are of such a capacity that, with one turbine unit out of service, the boiler may be operated up to 75 per cent capacity.

COAL IS CLASSIFIED by the Geological Survey according to the carbon-hydrogen ratio. This ratio ranges from about 10 for lignite up to 30 for anthracite.

Time Necessary for Cooling a Boiler

FACTORS TO BE CONSIDERED WHEN HEATING AND COOLING VARIOUS TYPES OF BOILERS

BY C. C. CUSTER

QUITE a diversity of opinion exists among practical engineers in regard to the time necessary to cool a boiler down for internal inspection. Some set the time at only a few hours and others at a day of 24 hr. This time should, of course, be governed only by how quickly the cooling may be done without doing any harm to the boiler and not by the convenience or inconvenience of the inspector who is waiting to enter the boiler.

Uneven contraction and expansion often sets up greater stresses in parts of boilers than those stresses caused by merely carrying the normal steam pressures for which the boiler may be built. For this reason it is well to use considerable discretion in firing up a cold boiler not to force it too hard at first, or it will show signs of distress eventually by leaking at some of its seams, due to fire-cracks developing, or to the loosening of flues or stays. The improper cooling down of a boiler produces similar unequal contractions and may result in serious damage. Some kinds of boilers are much more susceptible to unequal expansion and contraction than others and we wish to point out in this article that the way the setting is built around a boiler is often quite a factor in the case.

VERTICAL TUBULAR BOILERS MOST QUICKLY COOLED

Take, for the simplest example, a vertical, flueless, tubular boiler without stays between internal firebox lining and outside boiler shell, which allows the firebox lining to expand or contract without affecting the outside shell. This type in small diameters and low pressures is used extensively in cleaning and dyeing works and in processing for creameries. With this type you can get up steam in less than an hour. No setting has to be heated as the boiler is invariably insulated with about an inch of asbestos plastered on over chicken wire. The way to cool down this boiler with the greatest speed without doing it any harm is to pull the fire and hot ashes, then close all the drafts and open up a steam pipe to the atmosphere somewhere so that the volume of steam escaping about represents the steaming capacity of the boiler while it is being fired. As the pressure drops, the valve may be opened wider and wider, from time to time, till finally we have the valve wide open and only a little steam blowing out at practically atmospheric pressure. During this time the water in the boiler must be replenished from time to time from the regular source of supply to keep a uniform level of say three gages of water.

With the boiler down to atmospheric pressure and temperature, the drafts may safely be opened a little to help cool down the grates and ash pit, then the water in the boiler may be cooled by alternately drawing off a couple of gages and refilling and repeating this until the boiler becomes cold enough to drain it entirely and fill it with cold water, after which it may be emptied and opened up for cleaning and inspection.

This type of boiler is easily cooled for inspection in a little less than an hour and is almost fool proof as far as expansion and contraction are concerned. About the worst that can be done to it is for some fireman to open the firedoor while the boiler is popping off, leaving it open to reduce the steam pressure. This type of abuse on any vertical tubular boiler, if continued, invariably leads to fire cracks at the riveted joint where the door-ring is riveted to the shell. Better practice is to let it pop when it is hot and leave the fire and draft doors closed.

In case the vertical tubular boiler is of the flue type and built for higher pressures and heavily staybolted around the water leg with bolts pitched on about 4 in. centers, a type commonly used on portable dredges, steam shovels, etc., the boiler may be cooled down as described above but there is danger in blowing the water out of it too soon as it may cause cracked or leaky staybolts or leaky flue ends at the firebox. It should not, however, take much more than an hour to cool this kind of a boiler if skillfully done.

Consideration will be given next to locomotive fire box, double flame pass type of low-pressure heating boiler. This type of boiler is much used for heating buildings as it is self contained and is generally insulated on the outside by several layers of asbestos troweled on over chicken wire. When this type of boiler is fired up too fast from a cold state, the two extreme corner flues of the second pass have a tendency to spring a leak. This shows that the tube is expanding faster than the outside shell which is adjacent to it and thus has a tendency to work loose in the head. Such a boiler I think ought to have at least 2 hr. time to steam it up but after the fires are pulled may safely be cooled down by methods previously explained in an hour and one-half, as taking the heat from a boiler by letting out the steam and changing the water slowly produces fewer stresses than heating up a cold boiler with fire.

Brick Work Complicates Cooling Problem

In the case of a standard type horizontal return tubular boiler, while 2 hr. should be sufficient to steam up the boiler, the problem of cooling it down is somewhat complicated by the setting. In firing a cold boiler the brick setting takes up considerable heat. By tests made it has been found that a 2½-in. brick with fire against one side does not get thoroughly heated through in less than 2½ hr. Likewise a 9-in. boiler wall will keep on absorbing more heat and increasing in temperature for 9 hr. after the boiler is fired until it then reaches an equilibrium.

Conversely, after you pull the fire from such a boiler you can expect that the side walls will give out considerable heat for a period of 9 or 10 hr. thereafter. The sidewalls, however, where they do not touch the boiler do not affect the situation greatly. The part of the setting that is most important is that part that is in contact with the upper part of the shell. If this is composed of an inch or two of asbestos covering it will hold little heat but if composed of two layers of brick laid end to end in common lime mortar it will hold so much heat that it will heat back to the shell for 10 or 12 hr. after the lower part of the boiler is cooled. In the case of a water-tube boiler thus set with the steam drum insulated only with brick work, I often find the drums extremely hot to enter many hours after the tubes and headers are well cooled down. In a certain type of water-tube boiler with the headers rigidly connected to the steam drum, I have found cases where leaks were set up where headers were joined to the steam drums where I am certain the cause was unequal expansion of the tubes and headers as compared with the steam drums.

As an extreme case, the large Scotch marine boiler used on ships is considered. In such boilers the large diameters used require extremely heavy shells, an inch or more in thickness, which when riveted make a joint that is hard to bend under imposed stresses, and with large heavily stayed areas make this type of boiler susceptible to heating and cooling stresses. This is further complicated by the fact that it is fired internally, the fire box thus heating much faster than the outer shell.

When firing up a cold Scotch marine boiler of large diameter, it is considered necessary to devote about 5 hr. to warming up and artificial means are sometimes resorted to in order to produce a circulation in the boiler so as to make the shell and other remote parts heat more equally. This is done by using a circulating pump to pull the colder water from the bottom of the boiler and discharging it through the feed line into the top part of the boiler. Another way is to use a "Hydrokineter" which takes steam from another boiler and discharges it into the bottom of the cold boiler.

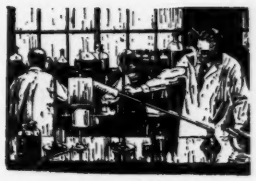
It is easy to set the joints, (particularly the girth joint at the side or bottom) leaking or produce leaky or broken stay bolts, by too rapid firing. Also it is a common occurrence to set up leaks around the ends of through rod stays. All staybolts of this type of boiler are equipped with tell-tale holes to indicate when they become broken. In this connection we may say that nearly all the broken stays that occur round the firebox of a locomotive boiler are occasioned by unavoidable contraction and expansion stresses rather than the pressure of steam. While a large Scotch marine boiler should have 5 hr. for steaming up, we may conclude that the cooling down is a much simpler problem, only requiring the gradual letting out of the steam and make up of necessary feed through the feed line and should take no more than a couple of hours if skillfully done.

We may therefore conclude that the time required for safely heating up or cooling down a boiler depends on: (A) The type of boiler,—how it is built and stayed internally; (B) How the setting is built around it; (C) The use of proper methods and facilities for heating or cooling down.

From a long experience in inspecting boilers, the writer has found many cases where conditions indicated that leaky flues, stays and seams and fire-cracks were caused by unwise handling rather than ordinary wear and tear so that these points should be borne in mind.

New orders for 689 steel boilers were placed in April, 1931, according to reports submitted to the Bureau of the Census by 73 manufacturers, as compared to 630 boilers in March, 1931, and 1017 in April, 1930.

Ground-glass cocks on Orsat sets require constant care to prevent sticking and leaking.



Significance of ALKALINITY *in* EMBRITTLEMENT STUDIES--*Part II*

The authors believe that the current A. S. M. E. ratio formula for inhibiting embrittlement requires reconsideration and revision. These conclusions were justified by the authors in Part I, while in Part II are presented the derivation and graphical solution of a ratio formula which considers all inhibitors which may be present.

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THE A.P.H.A., WINKLER and the abridged equilibrium methods were used to obtain data on the distribution of the bicarbonate, carbonate and hydroxide ions in boiler water. The samples of boiler water, obtained from six operating boilers, may be classified into three groups.

Samples 1 and 2, in the first group, represent boiler waters in which a relatively low phosphate treatment was maintained.

Samples 3 and 4, in the second group, represent boiler waters in which a relatively high phosphate treatment was maintained.

Samples 5 and 6, in the third group, represent boiler waters not treated with phosphate. Number 5 is zeolite softened water, No. 6, a lime and soda softened water.

Data shown in Tables I and II illustrate conclusively the inability to use the results obtained either by the A.P.H.A. or the Winkler methods, in order to evaluate the alkaline ions in the boiler waters.

Referring to Table I, it will be observed that the equilibrium method registers the bicarbonate ion in all the samples. Negative results are found by the Winkler method. Bicarbonate is absent in all samples except No. 2, when the A.P.H.A. method was applied. Considering the carbonate ion content of these samples, the equilibrium method registers low values in all samples except No. 5. These results vary widely from those determined by the A.P.H.A. and Winkler methods, except sample No. 5.

Correctness of the values for bicarbonate and carbonate, determined by the equilibrium method, was checked by estimating the total CO_2 by a weight method. The total carbon dioxide content of a measured volume of each of the waters was evolved with acid, the carbon dioxide was absorbed in Ascarite and weighed. The carbon dioxide so determined was calculated to the carbonate ion as were the results for bicarbonate and car-

TABLE I. BICARBONATE, CARBONATE AND HYDROXIDE, DETERMINED BY VARIOUS METHODS

Sample Number			1	2	3	4	5	6
Boiler Water Treatment (see below)			a	a	a	a	b	c
ION		METHOD	ALL VALUES IN PARTS PER MILLION					
Bicarbonate	(HCO_3)	A. P. H. A.	0	10	0	0	0	0
Bicarbonate		Winkler	neg.	neg.	neg.	neg.	neg.	neg.
Bicarbonate		Equilibrium*	5	7	0.4	0.2	1	0.6
Carbonate	(CO_3)	A. P. H. A.	23	18	238	111	50	110
Carbonate		Winkler	14	14	196	101	41	365
Carbonate		Equilibrium*	5	1	11	4	45	32
Hydroxide	(OH)	A. P. H. A.	8	0	73	21	98	291
Hydroxide		Winkler	11	2	95	25	101	271
Hydroxide		Equilibrium**	3	0.7	107	68	107	170

*Calculated from formula data in original manuscript, see reference No. 8.
**Derived from Curve, Fig. No. 1, using colorimetrically determined pH value.
Notes on Feedwater Treatment:
1a and 2a—Tri Sodium Phosphate added to feedwater—98% condensate returns 2% evaporative make-up. Boiler drum pressure, 265 lb./sq.in. ga.
3a—Tri Sodium Phosphate added to feedwater—100% condensate returns. Boiler drum pressure, 200 lb./sq.in. ga.
4a—Tri Sodium Phosphate added to feedwater—99% condensate returns, 1% evaporated make-up. Boiler drum pressure, 440 lb./sq.in. ga.
5b—60% condensate returns plus 40% zeolite softened make-up. Boiler drum pressure, 250 lb./sq.in. ga.
6c—90% condensate returns plus 10% lime and soda ash, cold intermittent process, make-up. Boiler drum pressure, 200 lb./sq.in. ga.

TABLE II. CARBON DIOXIDE AS CARBONATE BY VARIOUS METHODS

Sample No.	1	2	3	4	5	6
	CO_2 as CO_3 in parts per million					
Determined by evolution and gravimetric method	4	15	10	12	19	23
Calculated from A. P. H. A. method	23	27	238	111	50	111
Calculated from Winkler method	14	14	196	101	41	365
Calculated from Equilibrium method	10	8	12	4	47	33

TABLE III. SULPHATE, SOLUBLE PHOSPHATE AND DISTRIBUTION OF PHOSPHATES AND pH VALUES

Sample No.		1	2	3	4	5	6
Sulphate	p.p.m.	499	153	641	144	923	1614
Total Soluble Phosphate	p.p.m.	5	23	318	166	0	0
Phosphate Ion PO_4---	p.p.m.*	0.03	0.03	59	21	0	0
Hydrogen Phosphate HPO_4--	p.p.m.*	5	23	262	147	0	0
Di Hydrogen Phosphate H_2PO_4-	p.p.m.*	trace	0.03	none	none	0	0
pH value, colorimetric		10.3	9.6	11.8	11.6	11.8	12.0
pH value, electrometric		10.45	9.62	11.66	11.44	...	...

*The distribution of the phosphate to the various forms shown is based on the formula data in original manuscript, see reference 8.

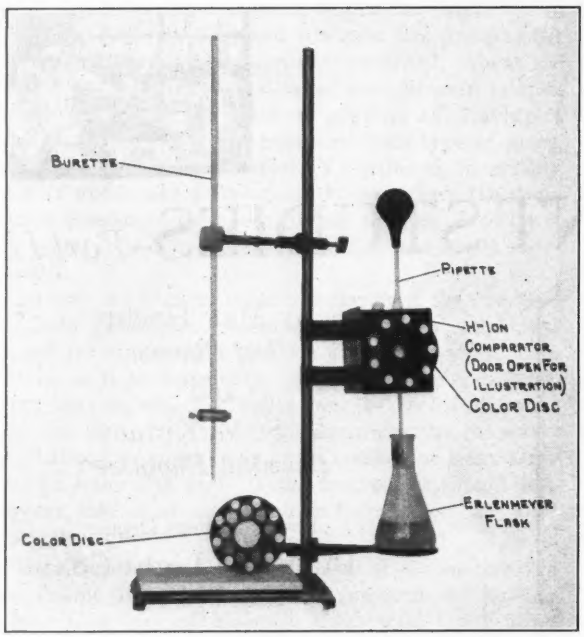


FIG. 2. APPARATUS FOR EQUILIBRIUM METHOD

bonate in Table I, determined by the three methods. These data are shown in Table II.

The equilibrium method is found to be the only one producing results which approximate the actual carbon dioxide content in terms of the carbonate ion of the waters.

Referring again to Table I and to the hydroxide ion values, it must be recognized that the hydroxide determined by the equilibrium method is not affected by titration errors. The OH derived from a determined pH value is fundamentally a correct method. Hence the values for hydroxide produced by the equilibrium method are essentially more accurate than those obtained by the A.P.H.A. and Winkler methods.

Referring to the data tabulated in Table III: Samples 1 and 2 were taken from boilers in which low amounts of phosphate treatment were maintained. Samples 3 and 4 were taken from boilers where high amounts of phosphate treatment were maintained, this, because of specific operating conditions. The authors interpret the hydroxide content in these samples, as the result of hydrolysis of the trisodium phosphate, the only treating reagent used in the "pure" boiler feedwater fed to the various boilers. Samples 5 and 6 were taken from boilers otherwise treated and the hydroxide content represents the hydroxide added as a treating reagent plus that due to the hydrolysis of the carbonate.

Comparisons of Inhibiting Ratio Formulas

When the values of the alkaline ions, Table I, and the sulphate and total soluble phosphate[9] contents of the boiler waters are used in the existing recommended ratio for inhibiting embrittlement and in the formula referred to in a preceding part of this presentation (inferred from Straub's conclusions), widely divergent values are obtained for the numerical significance of the ratios. These are shown in Table IV.

The numerical constant 20 assigned to the PO_4 and applied in formula B-4, is used by the authors, as might be suggested by Straub, on page 40 of Bulletin No. 216[2]. He states:

> "In case the alkalinity increases, the phosphate is increased about 20 parts per million for each 400-p.p.m. increase in alkalinity."

The authors interpret the term "alkalinity" mentioned by Straub, to mean OH alkalinity calculated as sodium carbonate.

With reference to the formula, the sulphate, total carbonate and total soluble phosphate are all considered inhibitors, and their effects are considered (by the authors) as additive. The authors present this calculation merely to show that the inhibiting characteristics credited to these ions must not be overlooked in embrittling studies.

No experimental data are available to determine whether the relationship of sulphate, total carbonate and soluble phosphate should be considered additive. The relationship may be so complicated as to require a graphical presentation similar to Fig. 4 (a reproduction of Fig. 41, p. 77, of Bulletin No. 216[2]), but including the

[9]The total soluble phosphate values, shown in Table III are used in the ratios calculated and presented in Table IV. Insufficient research data is as yet available to permit the assigning of specific values of the various forms of phosphate in proportion to the alkalinity of the water.

TABLE IV. COMPARISONS OF INHIBITING RATIOS

Sample No.	1	2	3	4	5	6
Nominal Boiler Pressure of Boiler lb./sq.in. ga.	265	265	200	440	250	200
A. S. M. E. Suggested Ratio	3 to 1	3 to 1	2 to 1	3 to 1	3 to 1	2 to 1
A.—Sulphate considered only inhibitant						
1. A. S. M. E. Formula, using						
a. A. P. H. A. Data (No PO_4 corrections)	11.2	5.6	1.5	0.8	3.5	2.2
b. Winkler Data (No PO_4 corrections)	10.8	7.5	1.5	0.8	3.5	1.6
c. Equilibrium Data	30.8	21.6	2.7	1.0	3.3	4.1
2. Hall Formula, using						
d. Winkler Data (corr. for PO_4 as per Hall method)	14.1	52.6	3.3	3.0	..	..
3. Straub Implied Formula, using $\frac{Na_2SO_4}{OH \text{ as } Na_2CO_3}$						
e. A. P. H. A. Data	28.8	infinity	4.2	3.3	4.5	2.6
f. Winkler Data	21.7	45.2	3.2	2.8	4.3	2.8
g. Equilibrium Data	69.6	103.8	2.9	1.0	4.1	4.5
B.—Sulphate, total carbonate and total soluble phosphate, considered as inhibitants.						
4. Formula $\frac{Na_2SO_4 + Na_2CO_3 + 20\ PO_4}{OH \text{ (as } Na_2CO_3)}$						
h. A. P. H. A. Data (No PO_4 corrections)	34.7	infinity	34.1	58.3	4.7	2.8
i. Winkler Data (No PO_4 corrections)	25.4	142.1	25.9	48.2	4.6	3.6
j. Equilibrium Data (Alk'y corr. for PO_4)	80.3	315.5	21.9	16.8	4.4	4.6

soluble phosphate. While the above formula does not include constants for concentrations of total salts and pressures, as previously suggested, it is evident that for a rational solution of the problem due regard must be given to all inhibiting ions in the boiler water rather than attempting to correct the alkalinity by some empirical constant.

Referring to the results shown in Table IV, and when sulphate is considered the only inhibitant, it is significant in Samples No. 1 and 2 wherein the soluble phosphate contents are low in amount that an extremely high ratio value is derived by all of the formulas, whereas, in Samples Nos. 3 and 4, both containing excessive amounts of the inhibitant, phosphate, the ratios are barely approximated. When the inhibitants, sulphate, total carbonate and soluble phosphate, are included in a formula, Formula B-4, then it is observed that all of the waters, either phosphate treated or otherwise, show adequate ratios. It is obvious that the power plant operator might well be disconcerted by the low ratio values when based on either the A.P.H.A. or Winkler test methods. He might be prompted to correct this apparent deficiency in the ratio, either by the addition of a sulphate salt, or by the addition of phosphate, or even by the neutralization of the alkalinity with acid.

In view of the considerations which have been presented in this discussion, it must be recognized that much of the field data on the alkalinity of boiler water tested in connection with embrittled boilers must be disregarded if the pH value of the water was not determined. If the pH values of the waters in connection with embrittled boilers are available, then the alkalinity data in connection therewith require recalculation. Such calculations would indicate that the graph Fig. 4 might present a different aspect as regard experimental points which are plotted to show agreement between actual operating conditions and Straub's theoretical curves.

Description of the Equilibrium Method

It is believed that consideration of the abridged equilibrium method and its use will overcome the difficulties which are apparent with either the A.P.H.A. or Winkler methods for evaluating the alkaline ions in water. The three steps in the procedure are easily made by the non-chemically trained power plant personnel.

Procedure for Equilibrium Method

Step 1. Determine the pH value of the water.

Step 2. A standard acid (0.02N) is added to a measured volume (100 ml.) of water until the pH value of the water measures 8.5 ± 0.1. The volume of acid in ml. is designated (V_1).

Step 3. A standard acid (0.02N) is added to a measured volume (100 ml.) of water until the pH value of the water measures 5.0 ± 0.1. The volume of acid in ml. required for the second sample is designated (V_2).

The amount of acid required for the change of the pH value from 8.5 to 5.0 ($V_2 - V_1$) is used to calculate the distribution and amount of alkaline ions in the water.

NOTE.—Cases may arise where the pH of the water, Step 1, is less than 8.5. In that event, add sufficient standard alkali (0.02N) until the pH value of the water measures 8.5±0.1. Designate the volume of the equivalent standard alkali as (V_3), remembering (V_3) = ($-V_1$). Then proceed as in Step 3. In this case, the amount of acid required for the change of the pH value from 8.5 to 5.0 is (V_2+V_3). The hydroxide concentration of the water is read from the curve, Fig. 1, for the observed pH, as determined in Step 1.

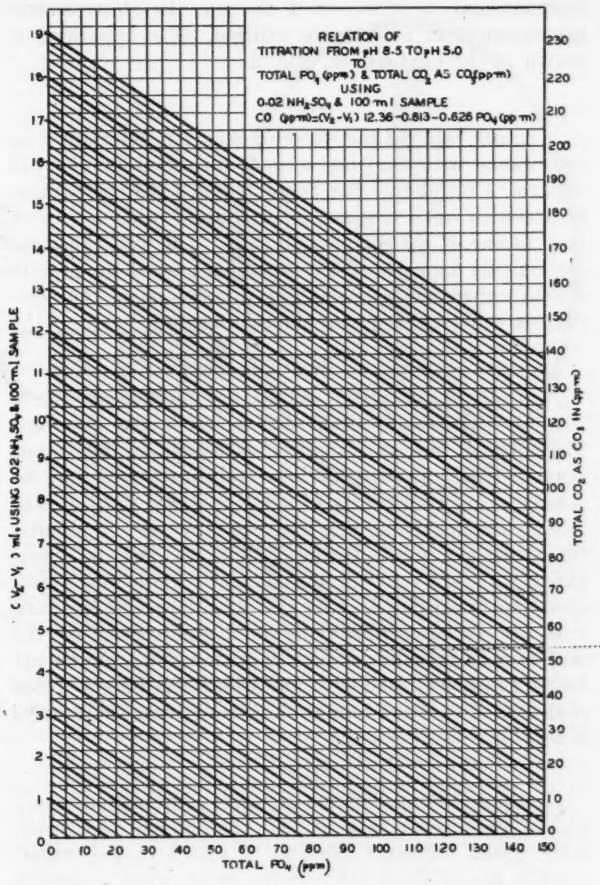

RELATION OF
TITRATION FROM pH 8.5 TO pH 5.0
TO
TOTAL PO4 (ppm) & TOTAL CO2 AS CO3 (ppm)
USING
0.02 NH2SO4 & 100 ml SAMPLE
CO (ppm)=2(V2-V1) 12.36-0.813-0.626 PO4 (ppm)
(V2-V1) ml. USING 0.02 NH2SO4 & 100-ml SAMPLE
TOTAL PO4 (ppm)
TOTAL CO2 AS CO3 IN (ppm)

FIG. 3. GRAPHIC SOLUTION OF THE ABRIDGED EQUILIBRIUM TITRATION METHOD

The carbonate (CO_3) concentration *(all of the CO_2 combined or otherwise)* is calculated from the amount of acid required in Steps 2 and 3, inserting the ($V_2 - V_1$) or ($V_2 + V_3$) in the following equation: $CO_3 = (V_2 - V_1) \times 12.32 - 0.813 - 0.626\ PO_4$ p.p.m. The derivation of this formula is given in Appendix B.

For the practical application in the field, the method as described uses the standard color glass discs commercially available in the apparatus furnished with the Hellige-Klett H-Ion Comparator. Other colorimetric

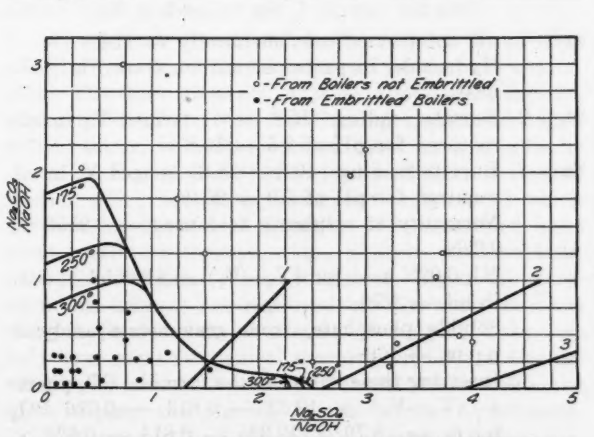


FIG. 4. RATIOS RECOMMENDED TO PREVENT EMBRITTLEMENT (REPRODUCED FROM FIG. 41, P. 77, BULLETIN 216[2]

methods may be used, or if desired, the electrometric measurement of pH may be utilized. The apparatus is shown in the photograph, Fig. 2.

STEP 1

The pH value of the water in Step 1 is determined in accordance with the instructions furnished by the pH apparatus supplier. For Steps 2 and 3 the comparator is provided with a glass pipette fitted with a rubber bulb as one of the comparison cells. The wall thickness and outside diameter of the expanded part of the pipette should approximate closely the dimensions of the comparison cell provided with the comparator.

STEP 2

100 ml. of the water sample are introduced into a 200 ml. Erlenmeyer flask; 0.2 ml. of a one per cent Thymol-blue indicator solution is added to the water. Standard acid (hydrochloric or sulphuric acid may be used) having a normality of 0.02N is added until a color change starting from blue to green is noted. A pipetteful of the solution is removed from the flask and compared with the color of the standard glass disc corresponding to a pH 8.5. The acid additions and comparisons are repeated until the final comparison of the sample with the disc is checked within ± 0.1 of the pH 8.5. The color change of the solution from blue to green is sharp. The volume of acid as read from the burette is recorded as (V_1).

STEP 3

Another 100 ml. volume of water is measured into a second Erlenmeyer flask; 0.2 ml. of a one per cent Bromcresol-green indicator solution is added to the water. Acid is added from the burette, as in Step 2, until a color change starting from blue to green is noted. A pipetteful of the solution is removed from the flask and compared with the color of the standard glass disc corresponding to a pH 5.0. The acid additions and comparisons are repeated until the final comparison of the sample with the disc is checked within ± 0.1 of the pH 5.0. The color change of the solution from blue to green is sharp. The volume of acid as read from the burette is recorded as (V_2). The soluble phosphate and sulphate ions are determined by the methods previously referred to.

EXAMPLE

Data for Sample 4, See tables 1, 2, 3.

Step 1. pH determined colorimetrically = 11.6
Hydroxide, in parts per million from Fig. 1 = 68.0

Step 2. Burette reading (15.8 — 0) termed V_1 in ml. required for pH of 8.5 = 15.8

Step 3. Burette reading (40.8 — 15.8) termed V_2 in ml. required for pH of 5.0 = 25.0
Normality of sulphuric acid used = 0.9553 × 0.02N
Ml. 0.02N acid for (V_2—V_1) = (0.9553 × 9.2) in ml. = 8.79
Soluble phosphate, from gravimetric analysis, p.p.m. = 166
Inserting these values in the formula, CO_3 p.p.m. = (V_2—V_1) × 12.32 — 0.813 — 0.626 PO_4 p.p.m. = (8.79 × 12.32) — 0.813 — 0.626 × 166 = 4.0

This formula is shown graphically in Fig. 3. When the volume of acid (V_2—V_1) and the PO_4 value is known, the CO_3 content can be read from the chart.

EXAMPLE

(V_2—V_1) = 10 ml. 0.02N Acid PO_4 = 50 p.p.m.

The intersection of the line projected vertically from 50, PO_4 on the diagonal 10, (V_2—V_1) is located on the chart. A line projected from this point horizontally to the right will be found to intersect the CO_3 scale at 91 p.p.m. which represents the total CO_2 as CO_3.

APPENDIX B.—DERIVATION OF EQUATION FOR CALCULATION OF TOTAL CARBONATE IN WATER FROM TITRATION BY EQUILIBRIUM METHOD, BETWEEN pH VALUES OF 8.5 AND 5.0

In the original manuscript, (see footnote 8), the original equation developed is:

$$H^+ = 0.0132 - 0.974C - 0.966P \quad (4)$$

H^+ = millimols H Ions to titrate one liter of water from a pH 8.5 to pH 5.0
C = Total Carbonate, millimols per liter
P = Total soluble phosphate, millimols per liter
and the constant
0.0132 = amount of H ions required to change the pH of pure water from 8.5 to 5.0

Let V_1 = ml. of acid required to reach the pH of 8.5
And V_2 = ml. of acid required to reach the pH of 5.0
And V_s = ml. of water under test
And N = normality of acid.

Then $(V_2\text{-}V_1)\frac{1000}{V_s} \times N = H^+$

CO_3 p.p.m. $= C \times 2 \times 30$, or $C = \frac{CO_3}{60}$

And PO_4 p.p.m. $= P \times 3 \times 31.68$ or $P = \frac{PO_4}{95.04}$

Substituting these values in Eq. 4

Then $(V_2\text{-}V_1)\frac{1000\ N}{V_s} = 0.0132 - \frac{0.974CO_3}{60} - \frac{0.966\ PO_4}{95.04}$

Solving for CO_3

$$CO_3 = (V_2\text{-}V_1)\frac{N}{V_s} \times \frac{(1000 \times 60)}{(0.974)} - \frac{(0.0132 \times 60)}{(0.974)} - \frac{(0.966 \times 60)}{(0.974 \times 95.04)} \times PO_4 \text{ p.p.m.}$$

which equation, when N = 0.02 and V_s = 100, becomes

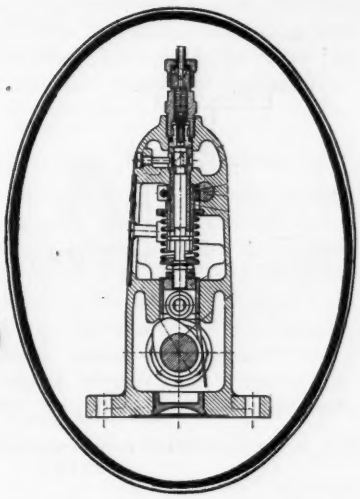
CO_3 p.p.m. = (V_2—V_1) × 12.32 — 0.813 — 0.626 × PO_4 p.p.m. (5)

Westinghouse to Supply Electrical Equipment for Hoover Dam

ANOTHER STEP in the construction of the Hoover Dam project was taken recently by the Six Companies Inc. of San Francisco, when it awarded to the Westinghouse Electric and Manufacturing Co. the contract for the electrical equipment of the Hoover Dam, according to W. R. Marshall, commercial vice president of the Westinghouse Electric and Manufacturing Co. A large part of the equipment covered by this huge contract will be built in the Westinghouse Works at Oakland, Calif. The award includes motors and control for driving all electric shovels, hoist pumps, conveyor and compressors, also electric locomotives, switching equipment, circuit breakers, switchboards and transformers, lighting arresters, and meters. Manufacture and delivery of this machinery will start at once.

IF IT IS at all possible to group meters and instruments together, they should not be scattered all over the plant. Decentralization divides responsibility and breeds lack of attention.

DIESEL ENGINE UPKEEP



PART XIII. FUEL PUMP TROUBLES AND HOW TO AVOID THEM. METHODS OF REMOVING FOREIGN MATTER FROM FUEL OIL. FUEL PUMP TYPES AND METHODS OF ADJUSTMENT. DISTRIBUTION SYSTEMS. BY EDWARD J. KUNZE

FAILURE of the fuel pump is one of the most frequent causes of shut-downs. Pump troubles are generally due to lack of proper attention. Among these troubles are leakage in the pressure line at defective connections, sticking of valves, solid matter getting into the line and entrained bubbles of air which interfere with proper atomization. All of these troubles may easily be avoided.

EXTREME ACCURACY DEMANDS SUPERIOR MAINTENANCE

When it is realized that for a 100-hp. cylinder operating at 200 r.p.m., the volume of a single full-load fuel charge is less than 0.2 cu. in. and that with the usual 2 per cent speed regulation requirement, the extreme variation in the volume of a single injection that is permissible is about 0.004 cu. in., the necessity for accuracy and proper care is apparent. Periodical inspection will reveal defects in the fuel-oil system and enable repairs to be made promptly.

Solid material in the fuel may interfere with the pump action or clog up passages in the system and water will interfere with the combustion process. Foreign matter may be brought in with the fuel oil or the fuel oil may be contaminated with dust brought in through loose covers, especially where storage tanks are underground. All foreign matter should be removed from the fuel before it reaches the fuel pump.

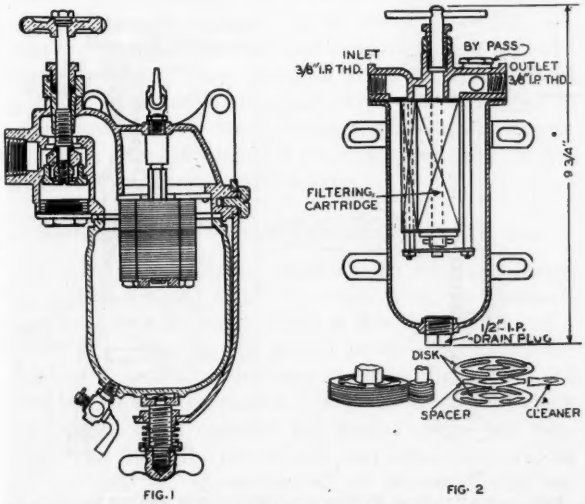


FIG. 1. METALLIC DISK FILTER. FIG. 2. SELF-CLEANING DISK FILTER

In some cases, this may be done by settling, in which case twin storage tanks are provided; one alone being used while the oil in the other stands quietly, permitting the sediment to be precipitated. If the fuel oil is extra heavy, sediment may not be precipitated freely; in such a case application of heat, by means of steam or hot-water coils or electrical device, will hasten action. Heavy oils require more attention in this regard than light oils because they carry more sediment in suspension.

STRAINERS AND FILTERS

Use of strainers and filters in various parts of the fuel system now is common. Filters composed of dense fabric may eliminate fine solids but they are difficult to clean and their resistance increases rapidly. Woven-wire gauze filters having adequate area are difficult to make and their cleansing is so troublesome that it is usually neglected. Often woven-wire filters are of too fine mesh and cause trouble in starting the engine, so operators frequently throw them out and the size of the mesh is increased progressively until little filtering action takes place.

Metallic-disk filters, with sufficient fineness and total effective area to be useful in Diesel service, are obtainable. The filter elements of these filters are composed of a number of circular disks having spokes and a hub which, latter, is used to center them on a spindle as shown in Fig. 1. Between the pairs of disks is a small washer which acts as a spacer, the thickness of which controls the fineness of filtration. The assembled disks form a cylinder through whose wall the oil flows from outside to center. While wire-gauze filters of corresponding fineness are ruptured readily when they are clogged, filters made of a stack of metallic disks, not only have great mechanical strength but may be cleaned readily by simply loosening the nut which holds the disks in place and placing them in gasoline or kerosene.

Self-cleaning, metallic-disk filters, Fig. 2, are so constructed that the built-up filtering cartridge is keyed

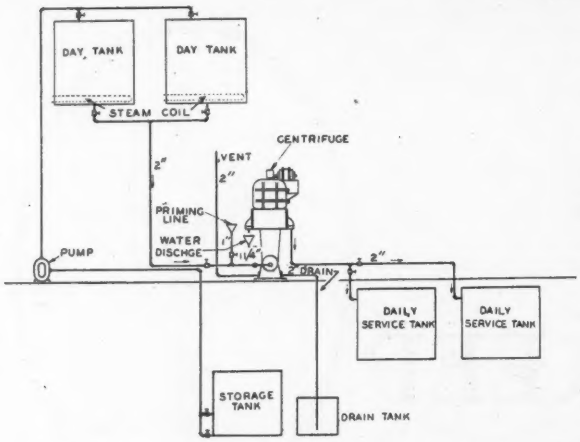


FIG. 3. ARRANGEMENT OF CENTRIFUGE AND FUEL OIL TANKS

to the central spindle which extends to the outside through a stuffing box thus permitting this cartridge to be rotated. Sheet-metal projections fastened to a spindle mounted close to the cartridge and penetrating into the spaces between the disks, comb out the collected sediment. As the cartridge rotates it is thus cleaned while the sediment falls into the filter casing and is blown out through the plug at the lower end of the filter. Metallic ribbon is wound edgewise around a cylindrical element, wire mesh and corrugations are rolled into the ribbon at regular intervals to act as spacers.

Centrifuging Removes Liquid and Solid Matter

Centrifuging, as a cleansing method for fuel oil, is increasing in popularity and is a valuable aid for improving fuel pump action particularly where heavy or extra viscous fuel oil is burned because of the larger quantities of water and solid material carried over by such fuel and the great resistance to flow which is characteristic of such fuel. The advantage of the centrifuge in this regard is due to the great pressure, amounting to about 9000 lb. per sq. in., which is set up by the centrifugal action. Since the fuel must be heated, at times, nearly to the gassing point, it is essential that centrifuges for fuel oil be capable of being closed vapor tight. Figure 3 shows a convenient arrangement connecting tanks and centrifuge in a fuel oil system.

Air Leakage Interferes With Pump Action

Since fuel pumps operate against a high pressure, it takes little air to stop them, therefore care should be taken to avoid air pockets in locations where air may collect. If the fuel is heavy or cold, the suction line too small or too long or if a suction lift exists, air may be drawn past the packing or valve tappets. Placing the tank higher than the pumps and using pipe of ample size and having as few bends as possible avoids many troubles from air leakage. If it is necessary to heat the fuel in order to give it proper fluidity, care must be taken not to heat it too high or gases, which may interfere with the operation of the pump, will be formed.

Even where there is a gravity head the fuel may not flow fast enough to follow the pump plungers of high-speed pumps or of medium-speed pumps that are working under adverse conditions. This is particularly true where a single pump is used or where the suction strokes do not overlap. To overcome this trouble, an air chamber may be placed as close as possible to the pumps so as to take up the surges and maintain a steadier flow from the tank. Since the fuel will slowly absorb the air in the air chamber, this air must be replenished from time to time. The amount of air contained in the air chamber may be seen at any time if the air chamber is made of glass.

Types of Fuel Pumps

Fuel pumps may be classified with respect to their method of influencing regulation, into three classes each

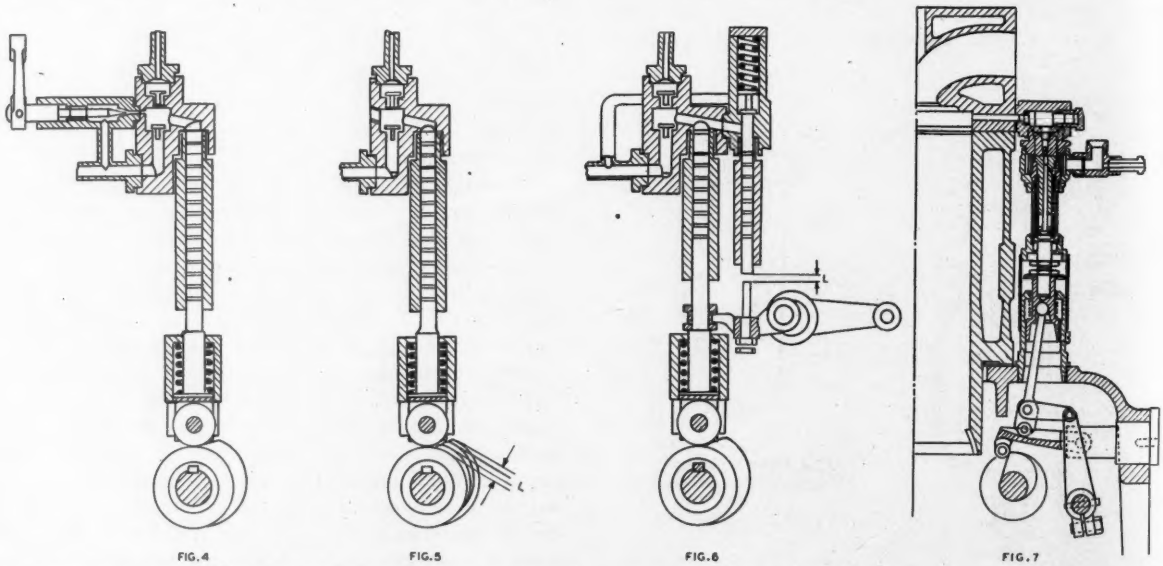


FIG. 4. CONSTANT-STROKE PUMP WITH THROTTLED BYPASS. FIG. 5. VARIABLE-STROKE PUMP WITH BEVELED-FLANK CAM DRIVE. FIG. 6. CONSTANT-STROKE PUMP WITH BYPASS CUTOFF. FIG. 7. VARIABLE-STROKE PUMP WITH CONSTANT-THROW CAM

of which has characteristics peculiar to the purpose for which it is used.

Constant-stroke pumps may be governed by a throttled bypass as shown in Fig. 4. With this simple and inexpensive construction, regulation is accomplished by a leakage outlet which passes fuel back to the suction piping throughout the entire discharge stroke, the amount of leakage being controlled by a needle valve. This type of pump gives fairly good service where the load on the engine usually is close to rated capacity. When the load is light, the throttling outlet is correspondingly increased and large amounts of oil are bypassed because of the reduction in the speed of flow; that is, it over-governs considerably.

Pumps with variable delivery strokes which are commonly built with a beveled-flank cam drive, as shown in Fig. 5, operate much better on variable and light loads. In this construction the cam rollers are ground either to a bevel corresponding to the beveled surface of the cam or their faces may be made semi-circular so as to adapt them to the sliding movement along the face of the variable sized cam. The force necessary to make the pump plunger move against the force of the spring and the fuel pressure, tends to move the cam sidewise so that considerable force must be exerted in positioning the cam for load control, therefore the governor must have sufficient power, properly to perform its function and extra care must be taken to see that effective lubrication is employed constantly.

One of the best solutions of the problem of pump regulation is represented in Fig. 6. The fundamental principle of this arrangement lies in maintaining an unvarying commencement of pressure stroke and opening a bypass duct at a point of time subject to governor control, the pump drawing in a quantity of fuel which is larger than that required for each working stroke at full load. Opening of the bypass may be effected either through thrusting open the suction valve or in opening a special bypass valve but this may be done also by the pump piston when it is constructed in the form of a slide valve and opens the bypass duct connected with the pump cylinder earlier or later according to the position in which it is held. The bypass passage may serve also as the suction inlet.

Variable-stroke pumps may be driven either by constant-throw cams with variable-ratio linkage interposed between them and the plungers as shown in Fig. 7 or by bevel flank cams. Constant-throw eccentric driven pumps are used for air-injection engines as the degree of timing control essential to airless-injection is not required by the air-injection type.

Refinement of Action Demands Proper Care

Necessity of adequate maintenance of fuel pumps may be appreciated better by considering the demands made on this mechanism. Only a few thousandths of a second elapse during the period in which pressure for injection is built up, discharge is accomplished and cut off of injection is completed. The pressures under which fuel pumps must operate are high; rarely are they lower than 1000 lb. per sq. in. and often they are as high as 6000 lb. Quantities of oil delivered with accuracy are so small that the normal leakage of plungers and valves often is a large proportion of the amount of discharge. The momentary rate of pressure rise from zero to that most desirable for good atomization and penetration must be extremely high while the rapid fall back to zero is equally necessary to prevent "after drip" and carbonization at the nozzles.

Uniform Distribution of Fuel Essential

In multi-cylinder engine systems employing a single fuel pump, some distribution method which will cause an equal load to be served to each cylinder is essential to economical operation. This is accomplished by means of mechanical distributors which switch the fuel from one spray valve to another, the amount of fuel usually being regulated by some bypass arrangement under governor control. A system of this kind is shown diagrammatically in Fig. 8. With this arrangement,

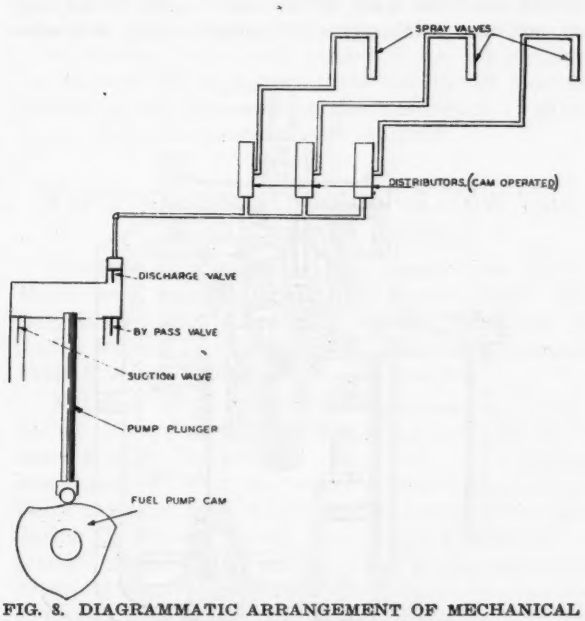


FIG. 8. DIAGRAMMATIC ARRANGEMENT OF MECHANICAL DISTRIBUTORS FOR SPRAY VALVES

either lightly loaded spray nozzles or differential valves may be used but the former will require a precombustion chamber to produce adequate turbulence. This system is known as the "common-rail" system. A fuel pump adapted to this system is illustrated in Fig. 9.

Direct injection with individual fuel pumps for each cylinder is increasing in favor for large engines that are required to handle fluctuating loads. Fuel pumps should be adjusted for equal delivery either while the engine is running under light or heavy load. During an idling period all the cylinders should be served just enough fuel to avoid misfiring. Rhythm of the exhaust sound is one means of regulating the fuel supply. Another method is to open try cocks in the exhaust pipe close to the cylinder head and observe the color of discharge. A missing cylinder will be revealed by a white or light-bluish smoke at the try cock. To remedy this, its fuel pump discharge should be increased until firing just takes place and the smoke disappears.

Speed change observations give another indication

of uniform operation. If the engine is operating under a substantial and steady load, and the speed of the engine observed when all cylinders are supposed to be firing, the drop in speed when one at a time the different cylinders are cut out by shutting off the fuel supply of that cylinder, may be compared. If excessive drop in speed results from cutting out any one cylinder, the indication is that this cylinder is receiving too much fuel when in operation.

Mechanical methods of equalization are also possible but the above methods are more reliable. Methods of equalization by means of indicators and pyrometers will be discussed in future articles in this series.

Pump Valve Maintenance

Pump valves and valve seats must be prevented from leaking. Poppet valves should be ground at regular intervals and the seats of the ball check valves kept smooth. On certain types of pumps, leakage will cause

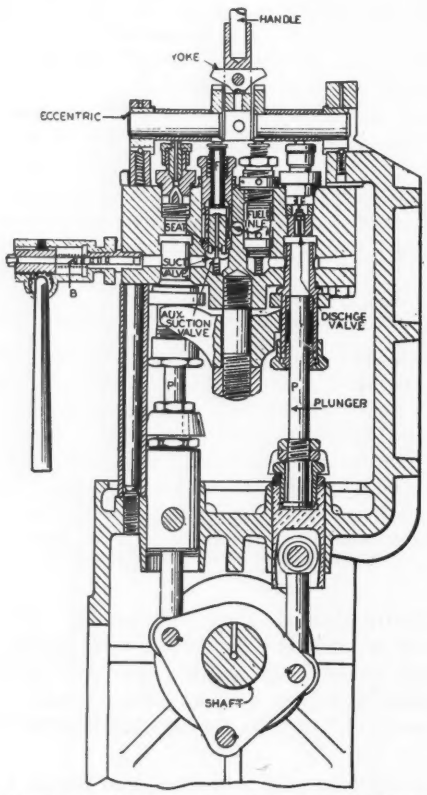


FIG. 9. FUEL PUMP CONSTRUCTION FOR A "COMMON-RAIL" DISTRIBUTION SYSTEM

fuel to be distributed back to other pumps through the suction valve that is not seating properly, thus causing injection into all cylinders at one time, resulting in unbalancing the engine.

When the valves are removed for examination, they should be cleaned thoroughly with kerosene. The lifts of the valves should be checked also and readjusted if the valve is reground. The clearance of the hand lifter should be checked also.

Continuous regrinding of a pump valve may lower it considerably. Care must be taken that the lower part of the stem does not touch other parts of the pump, under these circumstances, and prevent the valve from seating. If there is interference, the interfering end should be ground off.

Pump valves of the ball type may be reseated if the seat has worn slightly by placing a hardwood stick on the ball and striking the stick a light blow with a hammer. If the ball becomes worn it should be replaced by another ball. The lift of a ball valve should not be more than 1/16 in. Too high lift causes sluggish action in closing. If the lift is too high a light coil spring should be inserted above the ball to quicken its closing movement.

Grinding Pump Valves

In grinding pump valves of the poppet type, care must be exercised not to exert too much pressure on the valve while it is rotated. If the pressure is excessive, grooves may be ground in the valve face.

When leakage of valves is suspected, the best method of determining whether it exists is to disconnect the discharge line and attach a high-pressure gage to the pipe coupling. The engine can be turned over until the pump discharge pressure registers its usual pressures with closed and open nozzles. The engine should then be stopped and the discharge pressure noted. If this pressure falls, a leaky valve is indicated.

Examination should be made regularly of the fuel pump driving mechanism and adjustment made if it is found necessary. The plunger strokes of all pumps should be the same. Worn cams should be replaced promptly because, if wear is excessive, the operation of the engine will be greatly impaired. Levers and pins on old engines particularly may become badly worn. When this condition exists the pin bearings should be reamed to a larger diameter and new pins turned up to fit. For this work an expansion reamer is desirable.

Occasional breakage of valve springs due to fatigue is inevitable. Spare springs should be kept in store for replacement. Where packing is used it should be of the high pressure variety. Glands should not be tightened too much. Too great a pressure tends to bind the plunger, scoring it and increasing governor reactions. Present practice favors use of ground plungers without packing. Circumferential grooves are sometimes turned in the plungers to aid them in maintaining an oil tight surface. Pump plungers operate best if their length is at least eight times their diameter.

Bypass mechanisms require delicate adjustments particularly with small, high-speed multi-cylinder engines because of the extremely small charge; regrinding of valves is likely to cause unequal depth of the different valves, hence compensating adjustments must be made.

New orders booked during the first quarter of 1931 as reported to the Bureau of the Census by 85 manufacturers of electrical goods were $181,265,102 as compared with $208,935,443 for the fourth quarter of 1930 and $314,329,372 for the first quarter of 1930. The total includes motors, storage batteries, domestic appliances and industrial equipment, and is presented not as a complete statement of the industry but probably as sufficiently representative to indicate the trend.

Periodic reports of plant operation should be made.

Verein Deutscher Ingenieure

Seventy-Fifth Anniversary

By Walther Parey

Memorial Statue at Alexisbad to Founders of the V.D.I.

ON MAY 12, 1856, on a fine Whitsunday, twenty-three young and enthusiastic German engineers came to the small town of Alexisbad in the Harz mountains, with the idea of creating a rallying center for German engineers. They founded the Verein Deutscher Ingenieure and with youthful fervor—for none of them was over 30 yr. old—they set a high aim, "to coordinate the efforts of the best technical brains for the benefit of the whole industry of the country."

Recognizing, however, that concentration of the society's activities within one town would hamper development and progress, they provided for the creation of regional branches. Due to this system of decentralization, it has become possible for engineers in all parts of Germany to take active part in the work of the Verein by attending lectures and reading its publications. Today, the society has over 31,000 members with 53 district sections and 29 local branches in Germany. Also three branch societies in foreign countries—in Argentina, China, Japan.

As a means for spreading engineering knowledge, the founders created by Zeitschrift des Vereines Deutscher Ingenieure, which now appears in its seventy-fifth year. In its columns, many investigations have been published which have formed the basis of notable advances in engineering; also several other periodicals have been added, each dealing with a special branch of engineering.

Individual problems of engineering research are dealt with by special committees appointed by the VDI. The results are either published in suitable form or are laid down in the shape of codes, the best-known of which are the rules for acceptance tests on engines and on various plants and those for measuring procedure, such as the flow of gases and liquids.

In celebrating its seventy-fifth anniversary, the VDI will remember the founders, to whose far-seeing minds and organizing ability it owes much of its success. On the 12th of May, to their memory, a memorial was unveiled at Alexisbad, which shows a young engineer, his gaze fixed on the future, incorporating the words of one of the founders: "Now to work!"

In addition, this year's annual meeting, at Köln (Cologne) June 27 to 29, will be a jubilee celebration, with scientific events as the chief attraction. The principal lecture will deal with Radiation Problems, thus emphasizing the relationship between the problems of engineering and of modern physics.

In 11 professional meetings, papers dealing with the most important questions of present-day engineering will be read and discussed. A few of the subjects will be: Recent Research Concerning the Physics of Combustion; Welding in Boiler Construction; Diesel Engines for Driving Motor Trucks; Light Metals and Traffic Problems; Measures for Increasing the Speed of Travel; Problems of Working Lignite Mines; Flow Problems in Steam and Water-power Engineering.

Devoted entirely to serious work, the programme of the annual meeting is typical of the constant endeavour to promote the advancement of engineering by exchange of experiences. In this work, the Verein has the coöperation of the engineers of many other countries and it is expected that a large number of foreign engineering societies will send delegates to this Jubilee Meeting, thereby giving expression to this community of effort, which is for the benefit of all countries.

Westinghouse Announces New Gas Filled Mazda Lamp

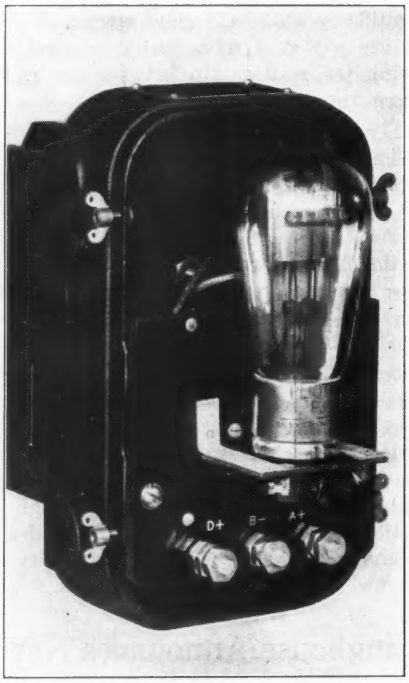
WESTINGHOUSE LAMP CO. announces a new 40-watt Mazda lamp, available on and after April 1, 1931. This lamp is available in the inside frosted finish and intended for use in residences and all general locations where it is not exposed to inclement weather.

Although certain important improvements are embodied in the design of this new lamp and although it has a slightly smaller bulb size, it will be in general interchangeable with the former 40-watt vacuum type. Being gas filled, there will be less blackening of the bulb during its life and it will have a better sustained or average efficiency and candlepower. Furthermore, its general strength or resistance to vibration is an improvement and from it, the user will obtain more light for his money.

For sign service and use in exposed positions, the former vacuum type of 40-watt Mazda lamp will be retained on account of its being better able to withstand snow and rain.

Inasmuch as this 40-watt size is one of the most popular lamps for general household lighting, this improved Mazda lamp, with its increased efficiency and better color of light, will be welcomed by the average consumer.

ANNUAL REPORT of Louisville Gas and Electric Co. and its subsidiaries for the year ended December 31, 1930, shows an increase in gross earnings of $228,289, or 2.20 per cent, and an increase in net earnings of $88,789, or 1.66 per cent, according to John J. O'Brien, president of the company. Net construction expenditures during 1930 totaled $6,148,118. A 132,000-v. transmission line, 82 mi. length, with a capacity of 40,000 kw., was completed, connecting the company's system with that of the Cincinnati Gas and Electric Co. at Cincinnati, Ohio. The construction budget for 1931 totals $3,100,000.



ELECTRON TUBES IN INDUSTRY

By W. R. King

Electron tubes were developed primarily for use in the field of radio communication but more and more uses for them are being found in industry. In this article which is an abstract of a paper presented before the A. I. E. E., the author discusses these applications.

ELECTRON TUBES have been in use in the radio and other communication fields for many years. It is only recently, however, that the field of application has been extended to include industrial uses.

The applications of electron tube systems may be broadly divided into two general groups, (1) those in which the electron tube devices perform operations for which no reasonably suitable apparatus of a conventional nature is available, and (2) those for which conventional apparatus already exists. Photoelectric devices, for example, have no strict competition from existing apparatus, while electron tube equipment supplying adjustable d.c. motors is, on the other hand, competitive with conventional apparatus and must be so considered.

In weighing the advantages and disadvantages of electron tube systems consideration must be given to the absence of major moving parts. Another advantage that is generally important is that electron tube systems can respond to controlling functions of very low energy level. The fragility of electron tubes has been a much discussed disadvantage, but this is a psychological disadvantage rather than an actual one for tubes are really more sturdy than they appear.

The Photoelectric Tube

The general theory of the photoelectric tube is well known. It is a two-element light sensitive device which depends for its operation on the emission of electrons from a light sensitive surface. Light falling on this surface results in the emission of electrons which are then drawn to the anode under the action of an external potential existing across the tube. Thus the current through such a tube varies in accordance with the amount of light falling on the light sensitive surface. These currents, however, are extremely minute (of the order of a few microamperes) and must be amplified before they can be made useful to operate relays or other instruments.

The most commonly used amplification systems employ a three element thermionic amplifier tube similar to those used in radio receiving sets. This type of tube will be referred to as the pliotron.[1] A relay capable of operating on the few milliamperes output of the pliotron, however, cannot control power circuits directly, nor even the operating coil circuits of medium size contactors or solenoids. It is necessary, therefore, to employ an additional small contactor before currents of the order of amperes can be controlled. In some applications this is perfectly satisfactory, but frequently applications are encountered in which the speed of response required is too great for this concatenation of relays. In such cases it has sometimes been found advantageous to use a thyratron.[2] The operation of the thyratron will be discussed more in detail later, but here we may consider it as an electron device which has an anode current of the order of amperes which may be controlled by certain functions of its grid voltage.

Color Analysis and Color Matching

Among the interesting applications of the photoelectric tube is the recording color analyzer. As its name implies, this device automatically draws for permanent record the color curve of a sample. The use of this device opens a new field to those working with color in view of the fact that the curve obtained from a certain sample is absolute identification for its color. It is not inconceivable that in the future numbers will be applied to the many curves and the arbitrary names

[1] Pliotron is the trade name for electrostatically controlled high vacuum discharge devices.
[2] Trade name for electrostatically controlled arc discharge device.

such as royal blue, cardinal red, canary yellow, etc., will be discarded for purposes of specification.

Applications requiring the continuous recording or indicating of amounts of visible energy on the photoelectric tube may be divided into three general classes; (1) light from a constant source passing through a substance of varying translucency or transparency to the photoelectric tube; (2) light from a constant source reflected into the photoelectric tube from a surface of varying reflecting power; (3) visible radiation from a varying source applied directly to the photoelectric tube.

Photoelectric equipment of this nature has been used to make continuous records of smoke densities. In an application of this type a beam of light is transmitted through the duct carrying the smoke and onto the photoelectric tube. The variation in smoke density permits more or less light to fall on the photoelectric tube, When properly calibrated, then, the photoelectric current is a measure of the smoke density. A recording milli-ammeter measures the amplified photoelectric current and the resultant chart shows graphically the smoke conditions at all times.

Photoelectric equipments have been employed to provide records of daylight intensities. While this application does not serve the utilitarian purpose that the smoke density recorder does, it has provided some interesting data on daylight intensity variations. Photoelectric tube and amplifying devices have been used for recording temperatures of hot bodies.

Relaying Applications

By far the greatest number of applications of photoelectric equipment which are operating at present are of the type in which an electric circuit is opened or closed in response to a certain change of illumination on the photoelectric tube.

In this manner street lights are being turned on in the evening and off in the morning in response to actual illumination requirements rather than according to a predetermined time schedule.

Room and factory lights as well as electric signs can also be controlled in response to illumination requirements, with the result that sufficient illumination is maintained at a minimum cost for lighting energy.

Perhaps the simplest type of application of photoelectric equipment is that in which a beam of light falling on the photoelectric tube is intercepted by a practically opaque object and some electric circuit is closed or opened accordingly. By this means, for example, objects passing through the light beam may be accurately counted. The amplified photoelectric current operates a small relay which controls a magnetic counter. Or, if higher speed is required, the relay may be replaced by a thyratron which will operate the counter directly. Photoelectric counters are being used commercially in counting automobiles, people, steel bars and billets on rolling mill tables, drops of oil in an automatic oiling machine, etc., etc., and are performing in such capacities in a thoroughly practical manner. Such a counting system offers distinct advantages in counting heavy objects which would soon destroy a mechanical counter, or small light objects which could not exert sufficient force to operate a mechanical counter.

This brings us to a consideration of photoelectric devices for limit switch operations. Their use in this capacity has made possible the automatic operation of machines in a manner which has not heretofore been practicable. Mechanical devices are not suited in some cases because of mechanical wear and tear, or because sufficient force is not available to operate them, or because of space limitations. It requires no additional force for a moving object to intercept a light beam; furthermore, the beam is in no way worn by the interception. In the manufacture of small cotton bags, photoelectric relays are being employed to initiate operations on the bags when they are in the proper position. Photoelectric relays are being installed in ore bins to indicate when the ore has reached the proper level. A number of large pipe facing machines have been equipped and are in operation with photoelectric devices to stop the traversing motion and advance the cutting tool when the pipes reach the proper position. In a number of instances photo-electric relays have replaced mechanical limit switches on rolling mill tables.

Photoelectric devices can be made sensitive to smaller changes in illuminations than those characterized by the applications involving the interceptions of a light beam by an opaque object. For example, photoelectric equipment is being used to indicate the proper operation of a filter in a sugar refining process. A beam of light is passed through the solution and if the solution runs cloudy due to improper filter operation the decreased translucency causes the photoelectric device to operate an alarm.

The Pliotron

The pliotron has other applications than that of amplifying the photoelectric currents referred to in the foregoing paragraphs. It is also a rectifying device and in this capacity it serves as a detector in radio sets. As an amplifying device it has many applications. In automatic train control systems, for instance, a small voltage is picked up from the tracks and amplified to operate signal devices in the engineer's cab. The pliotron also may be used as a very sensitive relay to respond to the opening and closing of delicate contacts or the contact between an electrode and a conducting liquid (such as water).

By a proper arrangement in which the grid of the pliotron is inductively coupled to the plate circuit oscillations may be generated. This constitutes their important use in radio transmitters. Under certain conditions if the coupling between the plate coil and the grid coil is changed, as by placing an iron vane between the coils, the oscillations will be stopped. This characteristic of the oscillating circuit has been employed in the automatic leveling of elevators. An iron vane in the elevator hatchway passes between the plate and the grid coil in an oscillating circuit on the car. When the iron vane is in the proper position the oscillations cease and a relay is closed, operating the control equipment which brings the elevator to a stop.

General Theory and Characteristics of the Thyratron

Practically speaking, the thyratron is a mercury arc or mercury vapor rectifier incorporating a control electrode or grid. In this device a few drops of mercury

have been introduced after exhaust. The current carrying capacity is due to electron emission from the hot cathode. The ionization of the mercury vapor, however, results in an approximately constant internal voltage drop of about 15 v.

The method of grid control is entirely different from that of the pliotron. For a given plate voltage, there is a particular grid voltage at which ionization will just occur, thus allowing the tube to pass current. If the grid potential is below this critical potential, i.e., more negative, no discharge will occur and no current will pass. As soon as the grid potential is increased above the critical voltage, ionization occurs and the tube passes current, providing the anode is positive with respect to

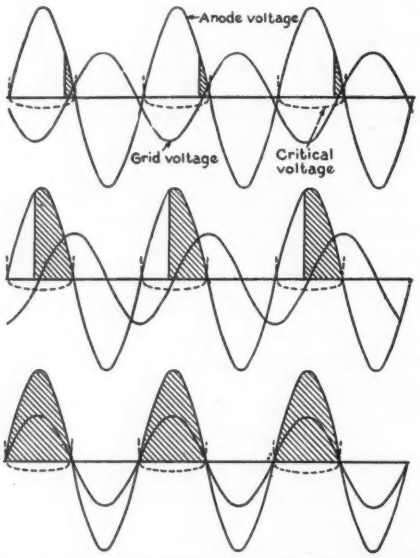


FIG. 1. CONTROL OF THYRATRON BY SHIFTING PHASE OF GRID VOLTAGE

the cathode. Once the anode current is started, the grid has no appreciable effect on it. The grid cannot limit or stop the flow of current, but can regain control to keep it from starting again if the flow ceases long enough for the mercury vapor to deionize.

If an a.c. voltage is applied to the plate, the grid has an opportunity of regaining control once each cycle and can delay the start of the arc for as long a period during the cycle as the grid is sufficiently negative. Therefore, if the grid as well as the plate is supplied with an alternating current, the phase relation between the grid and plate voltage determines the point in the wave at which current begins to pass in each cycle, hence the average amount of current passing through the tube. Figure 1 shows this relationship for one anode as the phase of the grid voltage is shifted from almost 180 deg. lagging to almost in phase with the anode voltage; the shaded portion indicates the passing of current.

The Thyratron as a Relaying Device

The operation of the thyratron as a relaying device differs greatly from the operation of other relaying devices. It cannot be used as a direct current circuit interrupter. It may be used as a "valve" to "start" direct current in a circuit but cannot readily stop the current flow as long as the anode remains positive. It can be used, though, to start and stop a flow of current if alternating current is applied. The current which passes, however, is not alternating but is half-wave pulsating direct current if one thyratron is used. By using two tubes, so connected that one passes current in one direction on one half cycle and the other passes current in the opposite direction on the succeeding half cycle, it is possible to pass alternating current. This

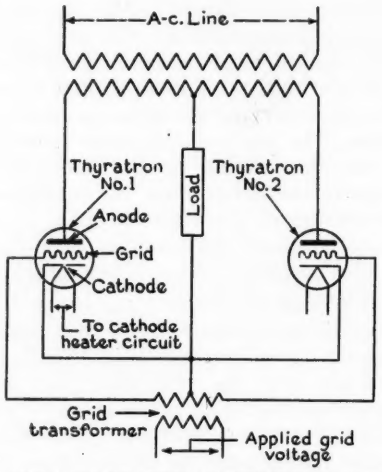


FIG. 2. FULL WAVE GRID CONTROLLED RECTIFIER

complication is not generally found to be warranted, however. The other major difference between a "thyratron relay" and an ordinary relay is that the thyratron has an approximately constant internal voltage drop of 15 v. This drop is substantially constant for all values of current within rating but varies slightly with ambient temperature, filament voltage, life of tubes, and between individual tubes.

The field of the thyratron as a relaying device is chiefly in controlling solenoids, contactor coils, mag-

FIG. 3. FULL WAVE OUTPUT VOLTAGE WAVE FORM FOR A RESISTANCE LOAD

netic brakes and clutches, etc. Such devices may be wound to operate from the half-wave direct current voltage resulting from the application of commercial alternating current voltages to the thyratron. Such a system involves no contacts and furthermore very high speed operation can be secured. The thyratron grid circuit may be controlled by a change in either voltage or current directly; or by a change in reactance, capacitance, or resistance resulting in a change in voltage or a shift in phase of the grid voltage; or by the opening or closing of delicate contacts. In each case the change in the grid circuit must be sufficient to be independent of the slight variations in the critical grid voltage of the thyratron.

For example, the amplified current of a photoelectric tube may be used to control the thyratron. To accomplish this, a resistor is connected in the plate circuit of the pliotron and the voltage drop across the resistor is used to control the grid voltage of the thyra-

tron and thus determine whether it shall conduct or not conduct. In this manner a change in illumination on a photoelectric tube may be employed to operate a solenoid or similar device without the aid of any contact making or moving part device whatever.

Similarly the change in reactance in a coil caused by moving an iron core in it may be used to shift the phase of the thyratron grid voltage and control the operation of a magnetic clutch or brake.

One relaying device has been developed in which thyratrons are employed to short circuit the high voltage secondary of a series transformer whose primary is connected in series with a resistance welding transformer. The change in the impedance of the primary of

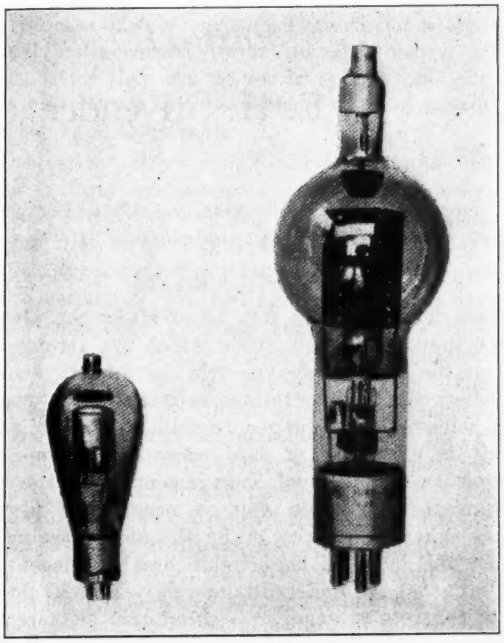


FIG. 4. SHOWING RELATIVE SIZE OF A 2.5 AMPERE AND 12.5 AMP. THYRATRON

the series transformer as the thyratrons are alternately permitted by their grids to pass current and not pass current, makes it possible to control at high rates of speed the intermittent flow of current to the welding machine without any mechanical wear and tear or burning of contact tips as experienced in mechanical interrupters and contactors.

The Thyratron as a Controlled Rectifier

Although the thyratron operates as a "controlled rectifier" in most applications, this term is used more particularly to denote the application of the thyratron in the production of a pulsating direct current from an alternating current, the voltage of which may be varied smoothly without steps by properly controlling the thyratron grids.

The simplest system of this type is the single phase full wave grid controlled rectifier shown in Fig. 2. While this is similar to the ordinary full wave rectifier due to the grid control the operation is quite different.

If the grid voltage in such a system is made to lag the anode voltage, the grids will not become positive when their respective anodes become positive and conduction in each half cycle will not commence until the grids have become less negative than the critical grid voltage. As the phase of the grid voltage is made to lag the anode voltage more and more the point at which conduction begins comes later and later in each half cycle, conduction occurs for shorter and shorter periods and consequently the average voltage across the load is decreased. Finally when the grids lag their anodes by 180 deg. no conduction occurs.

To make the system useful it is necessary to devise a means for shifting the phase of the grid voltage in response to electrical functions or mechanical movements. This can be accomplished in various ways, i.e., by a reactance-resistance bridge, by a small saturable core reactor, or by a small induction voltage regulator.

The first important commercial application of thyratron control was in the lighting system of the Chicago Civic Opera. Another use for this thyratron system is in supplying small d.c. motor armature power, somewhat after the manner of a non-reversing, non-overhauling Ward-Leonard system. With thyratrons at present available for industrial use, it is possible to supply armature power for motors up to 5 hp., 230 v., and yield excitation up to 5 kw., 230 v. Power for motors larger than 5 hp. would have to be taken from a 3-phase distribution and a 3-phase rectifier circuit would have to be used.

Ford, Bacon & Davis Construction Corp. has been formed as a wholly owned subsidiary of Ford, Bacon & Davis, Inc., to handle all contract construction activities for the entire organization. The new company was organized under the laws of New York State and will have executive offices at 39 Broadway, New York City, and field offices at Dallas, Texas.

Officers of the company are Edgar G. Hill, president, James F. Towers and William von Phul, Jr., vice-presidents, and Henry F. Storck, secretary and treasurer. Mr. Hill and Mr. Towers are also vice-presidents and directors of the parent organization. Mr. von Phul, Jr. will manage the Dallas office of the new company and direct its field activities in oil and gas pipe line projects.

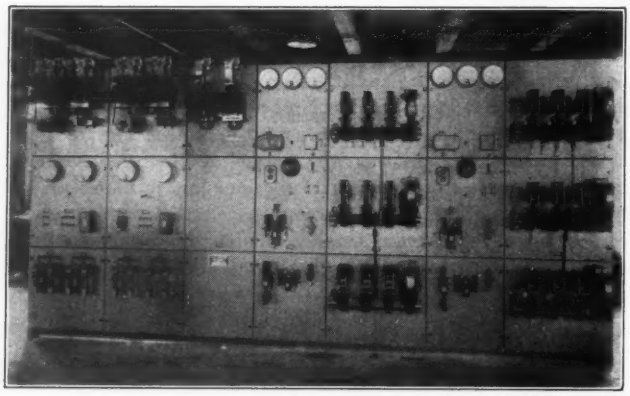
Projects now under construction by Ford, Bacon & Davis, Inc. include the last link of the 960-mi. Texas Panhandle-Chicago natural gas pipe line, a section 155 mi. long; the East Texas-Shreveport oil pipe line for a Cities Service subsidiary and the Western Gas Co. development. The organization also built the third section in the Texas-Chicago line.

In a process developed by Lukenweld, Inc., gear blanks 24 in. outside diameter and over are made from rolled steel plate by gas cutting the pieces for hubs, webs and ribs, forming the ribs into channel sections as required, then welding webs to hub and ribs. The gear rim for the teeth is gas cut, then bent to a circle and welded to webs and ribs. Material generally used is S. A. E. 1020 carbon steel but rims can be furnished if special material is desired. In this process no patterns are used, as parts are cut and joined to blueprint design, thus saving in cost and time. Material is homogeneous so that all parts are sound and the work of machining and cutting teeth is made certain and speedy.

Control of Electrical Equipment *in* Industrial Plants

Part II

by E. H. Stivender



IN ADDITION to the types of relays described in the preceding article[1] which were mostly designed for overload protection, relays are used for other purposes. On polyphase motor circuits provision is sometimes made to open the circuit breaker in case of open or renewed phases. Reverse phase relays operate on the principle of the polyphase induction motor; when the phases are reversed the relay element will tend to reverse rotation, closing its contacts.

Relays which open the circuit breaker when an unbalanced three-phase load occurs are known as "phase balance," or "phase unbalance" relays. They are particularly adapted to three-phase motor circuits, possessing the feature of allowing any degree of balanced load to be placed on a motor, but in the event of a short circuit between phases or from one phase to ground, can be set to open the circuit breaker immediately. A single overload relay in the motor circuit will guard against excessive balanced currents, while phase balance relays will interrupt unbalance short circuit currents before they reach high values.

One type of relay for this purpose employs the principle of the wheatstone bridge; the circuit is balanced under normal load conditions, but in case of an open phase, unbalanced phases or reversed phases, current will flow through an induction relay element which operates the contacts. Another type uses the principle of two relay magnets normally producing opposing torques or a disc. When an open or unbalanced phase condition occurs, one element produces more torque than the other, thereby causing the disc to rotate and close the contacts. Relays of this type are often manufactured with an overload relay in the same case, since in most instances it is desirable to have balanced overload protection as well as unbalanced phase and one phase protection. This relay does not protect against reversed phases.

Two relays for phase balance in connection with one overload relay will give complete protection against abnormal current conditions.

Undervoltage Relays

Undervoltage relays may be of either the plunger or the induction type. Those which are arranged to act on the circuit breaker trip mechanism directly are often called undervoltage releases. They consist of a solenoid and plunger combination. While the circuit is energized at safe operating voltage, the plunger is held out of engagement with the trip mechanism; when low voltage occurs the plunger moves either by gravity or by the aid of springs to release the latch of the circuit breaker mechanism.

Plunger type undervoltage relays which close a set of contacts to energize a shunt trip coil are similar to current relays of this type. When the plunger is released by its solenoid, contacts are closed which close the circuit of the usual trip coil. This type of relay when used with remote control is mounted either on the switchboard or on the circuit breaker. It is usually provided with a time element.

Induction type undervoltage relays are similar in appearance and operation to induction overload relays. A spring moves the disc against drag magnets to close contacts when undervoltage occurs.

Overvoltage relays are sometimes of advantage. They are of the same operating characteristics and appearance as undervoltage relays.

Undervoltage protection is in most cases important. Induction motor will overheat and stall under load when the voltage becomes of too low a value. Synchronous motors will pull out of step and stop.

Motors that are required to start on low voltage must be disconnected from the line when the line becomes deënergized, thus precluding the possibility of them being energized at full voltage should line voltage return before the circuit breaker can be opened manually.

Differential protection consist of placing current transformers in the line and neutral ends of each phase

[1]See Part I, page 511, May 1 issue.

winding of a motor. It is used to disconnect the line immediately should a short circuit occur within the motor.

This scheme is used independently of any other form of protection and will cause opening of the circuit breaker only when a fault occurs between the current transformers in the line and neutral ends. The current transformers in the line side are frequently placed so as to include the circuit breaker in the protective network.

As heretofore explained, it is nearly always preferable to have a time characteristic in overload relays in order to preserve continued operation during intermittent overloads. For this reason, differentially connected relays are desirable for the clearing of apparatus in case of short circuit. They cannot be operated by overloads caused by mechanical output of the motor, hence they can be set to operate on light currents and almost instantaneously when overloads due to other conditions occur.

Protective relays which can be set and checked easily are finding the most general use in present-day practice. In continuing the trend toward centralized control, it is frequently desirable to place all protective relays on a main switchboard in industrial plants; thus accessibility for testing and checking is more readily obtained. In many cases, however, it is not practical to mount the relays of all the motors on a common panel, complications and expense of equipment required to prohibit this practice, hence it is a general procedure to mount relays directly on or near circuit breakers. Advantages which characterize this practice are a minimum space required for switchboards and shorter instrument transformer leads, since the instrument transformers are generally placed within or near the circuit breakers. Standard types of protective relays seldom require maintenance other than periodic inspection; therefore in the case of industrial plants centralization of relays is mostly limited to substations and generating stations, where it is practical to centralize the circuit breakers.

One of the most popular systems of control for small motors consists of a compact cabinet enclosing an air-break power contactor and a 3-phase temperature relay. Since the contactor is often operated from a push-button station or an automatic switch, the holding coil is energized through "break" contacts of the temperature relay, until the relay operates.

Shunt Tripping Devices

There are a number of different schemes used for tripping circuit breakers. As pointed out earlier, direct current trip circuits in connection with storage batteries are desirable in that they offer a means of making the trip circuit independent of the power source. When a small battery is the source of power for tripping, the reliability of the direct current system is reduced greatly if a battery of very low voltage rating is used. The contacts of ordinary relays will sometimes fail to carry sufficient trip coil current at voltages below 24 v.

The need of dependable tripping devices and circuits cannot be too strongly emphasized. Numerous disastrous results may follow the failure of a circuit breaker to open when abnormal current and voltage conditions occur.

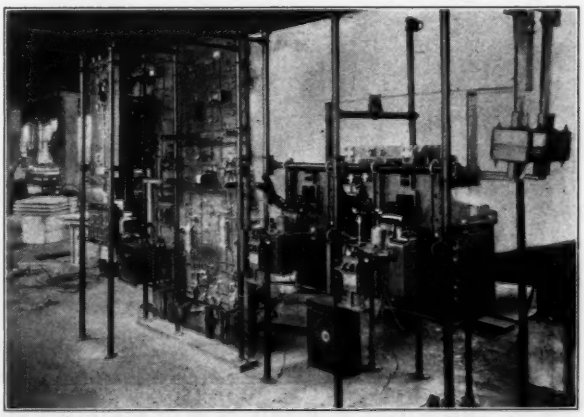
Shunt trip coils energized from an alternating current source cannot safely be used in connection with protective relays unless the alternating current control source is separate from the power source, or unless separate low voltage releases on the circuit breaker mechanism are employed. Even when the control source is separate, it is often undesirable to depend on shunt trip coils for protections, due to the possibility of failure at a critical moment.

It is always preferable to connect the shunt trip coils in series with auxiliary contacts on the circuit breaker mechanisms. In this manner the trip coil current is broken when the circuit breaker opens; thus more sensitive contacts in the protective relay system are not burdened with excessive current breaking, with consequent burning of the contacts. This practice also insures the trip coil against carrying prolonged currents should relays such as undervoltage and hand reset devices be left closed too long.

Since most shunt trip coils are energized at full voltage only during the interval between the closing of the trip circuit and opening of the circuit breaker, they are generally not designed for much heat radiation, the thermal capacity of copper being of sufficient value to prevent any undue temperature rise in the insulation. Should the circuit breaker fail to open when the trip coil is energized, a burned out coil is often one of the results. For use on oil circuit breakers, such coils carry approximately one ampere on 100-125 v. control circuits and one-half ampere on 220-250 v. circuits.

Plungers of trip coils must be of sufficient weight to fall back in place when the coil is deënergized.

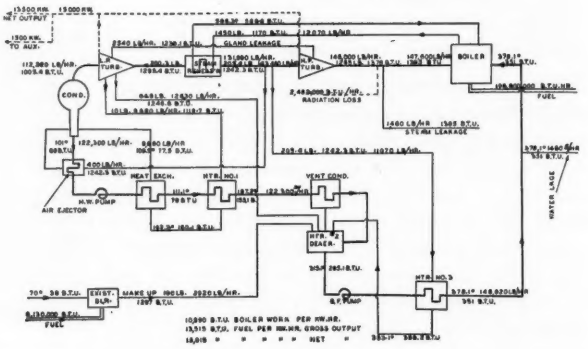
Shunt trip coils used in alternating current control circuits cannot always be used satisfactorily in direct current control circuits, and coils intended for direct current control are unsatisfactory in alternating current circuits. The operating current value of an alternating current coil is determined chiefly by its inductance hence it will often draw excessive currents when energized with direct current. Coils designed for direct current generally offer excessive reactance to alternating currents.



REAR VIEW OF AN AUTOMATIC CONTROL FOR SYNCHRONOUS MOTOR AND SINGLE PHASE A.C. GENERATOR

1400 LB. in TEXAS

San Antonio Public Service Co. superimposes high pressure equipment on old 190 lb. plant in one of the most interesting high pressure installations yet made.



BECAUSE of load conditions, simplicity of the layout and ingenuity displayed in utilizing the limited space available, the new 1400-lb., 20,000-kw. unit of the San Antonio Public Service Co. at its Concepcion Road Station probably has more widespread practical interest than any previous high pressure installation.

Briefly the new plant consists of a 1450-lb., 810-deg. Foster Wheeler steam generating unit, with a maximum capacity of 215,000 lb. per hr. supplying steam to a Westinghouse 8000-kw. high-pressure turbine. This turbine exhausts at approximately 200 lb. pressure to a 2060-sq. ft. steam reheater where the temperature is raised to 550 deg. F. before expanding to condenser pressure in a 12,500-kw. low-pressure turbine installed in the old plant a number of years ago. The low-pressure turbine bled at 2 points for feedwater heating is limited to a 550 deg. F. steam temperature. Condensate from the condenser hotwell passes through the air ejector coolers, a 160-sq. ft. heat exchanger and a 700-sq. ft. low-pressure heater to a deaerating heater. The low pressure heater is supplied with 10 lb. steam and drains through the heat exchanger to the condenser hotwell. The deaerating heater is supplied approximately 85 lb. gage extracted steam.

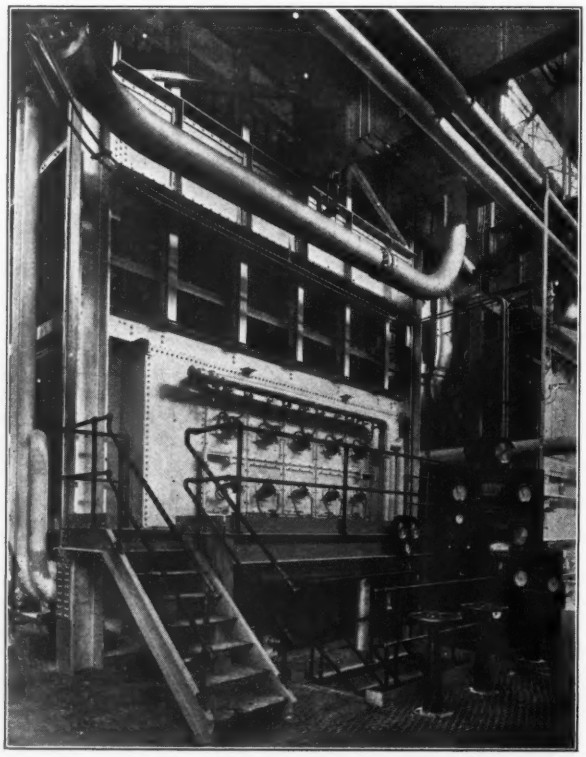


FIG. 1. THE BOILER IS FIRED BY 10 COMBINATION OIL AND GAS BURNERS

Both the air ejector and the 475-sq. ft. high-pressure heater take steam at the cross-over pressure of 205 lb. The boiler feed pumps take their suction from the deaerating heater and pump through the high-pressure heater and economizer to the boiler, delivering the water to the economizer at approximately 380 deg. F. The makeup is supplied from the old low-pressure boilers and enters the system through the deaerating heater. The heat balance at the top of the page shows a gross load of 15,000 kw. (13,500 kw. net output) at which load the heat rate is 15,015 B.t.u. per kw-hr. gross (or 13,515 B.t.u. per kw-hr. net) output.

Because of the widespread interest in this station a view of the conditions leading up to the installation may be of interest. In 1929 the chief source of power of this system was the 60,000-kw. Comal steam station about 30 mi. from San Antonio and producing energy for approximately 16,300 B.t.u. per kw-hr. A secondary supply was the 30,000-kw. station B in San Antonio with a B.t.u. rate of 26,000. The total demand on the system was approximately 54,000 kw. and rapidly increasing.

During system surges such as occasioned by electric storms, it was desirable to have a power input of approximately 5000 kw. from the San Antonio station to prevent a general outage. Consideration of reduced cost of operation and increased reliability, by having some power generated near the center of load, indicated that the installation of a high-pressure unit exhausting into

one of the present units at station B or Concepcion Road Station would handle the situation nicely and would be somewhat cheaper and more efficient than an entirely new medium pressure station. The added capacity gained would probably postpone the installation of a large unit for at least a year. It was desirable to keep the installation as simple as possible and this was done by the method outlined above, by means of a single boiler and a single turbine unit.

The boiler shown, in front view by Fig. 1 and cross section by Fig. 2, is a Connelly cross-drum unit with a surface of 4990 sq. ft. normal capacity of 153,000 (maximum capacity 215,000 lb.) of 1450 lb., steam per hour. The bare tube convection superheater, made up of 2-in. diameter ¼-in. thick elements with a total surface of 4640 ft. is designed to superheat 196,000 lb. of saturated steam to 810 deg. F. at a superheater outlet pressure of 1362 lb. Gases after making a single pass through the boiler and two passes through the superheater, enter an 11,800-sq. ft. steel tube economizer at approximately 1200 deg. F. where they are cooled to approximately 520 deg. F. before entering the air preheater. The plate type air preheater has a surface of 13,900 sq. ft. and is designed to heat 192,500 lb. of air from the outside temperature of approximately 80 deg. F. to 342 deg. F. The flue gas temperature drops from 520 to about 350 deg. at the maximum rate.

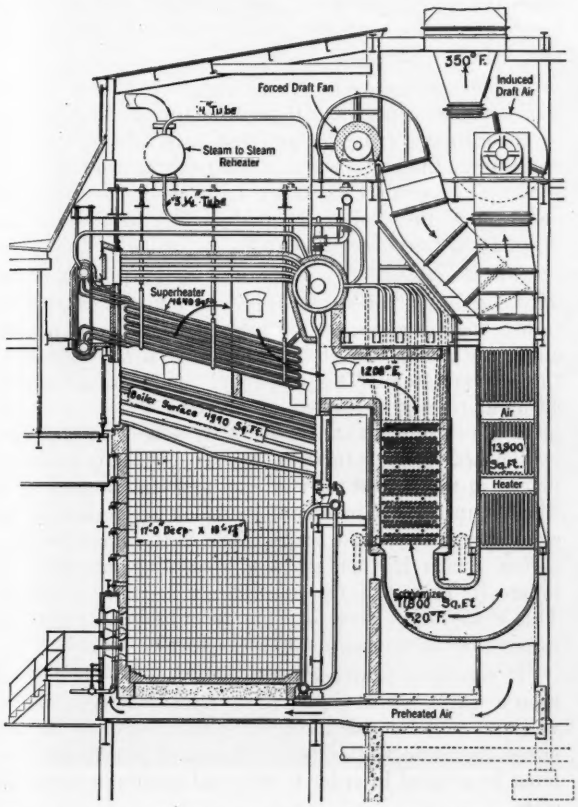


FIG. 2. CROSS SECTION OF THE 215,000 LB. PER HR. 1450 LB. BOILER AT CONCEPCION ROAD STATION

The air heater is made up of six interchangeable sections and arranged in two parallel groups of three sections each. Air for combustion passes horizontally through the sections, entering the two sections at the center and leaving the bottom sections at the outside ends.

Three Fuller Lehigh water-cooled walls total 1011 sq. ft. and the furnace with a total volume of 7018 cu. ft. is designed for maximum heat release of approximately 39,500 B.t.u. per hr. Fuel is fired by 10 Peabody combination gas and oil burners designed to liberate 27.7 millions B.t.u. per hr. each. When fired by natural gas the efficiency, including the reheat, is expected to vary from 81 to 83 per cent depending upon the rating. When oil fired the efficiency varies from 83 to 85 per cent, the figures being based upon a maximum dry gas loss of 6.6 per cent and a constant unaccounted for loss of 3 per cent, the balance being the loss due to moisture formed by combustion of the gas or oil.

Both the forced and induced draft fans are installed above the boiler as can be seen from the photograph of the air preheater, Fig. 3. The roof of the boiler room was raised, but the new boiler unit is so much larger than the former one that the air preheater and economizer were placed outside the building with the wall between the economizer and boiler as shown by Fig. 2. The damper controlled, forced draft fan driven by a constant speed induction motor, capacity 70,000 c.f.m. at 110 deg. F. and 11 in. static pressure and takes its suction from the top of the boiler room, discharging downward through the air preheater and under the floor to the burners. The induced draft fan, also damper controlled, is driven by a constant speed induction motor and has a capacity of 110,000 c.f.m. at 416 deg. F. and 13-in. static pressure.

As shown by Figs. 2 and 4, the steam reheater built for a working pressure of 1450 lb. per sq. in. is installed directly above the boiler and is supplied with saturated steam at full boiler pressure through a 4-in. line. It is drained by gravity back to the boiler drum through a 3¼-in. line. The heating surface consists of 600 tubes

FIG. 3. LIMITED SPACE MADE IT NECESSARY TO PUT THE ECONOMIZER AND AIR HEATER OUTSIDE

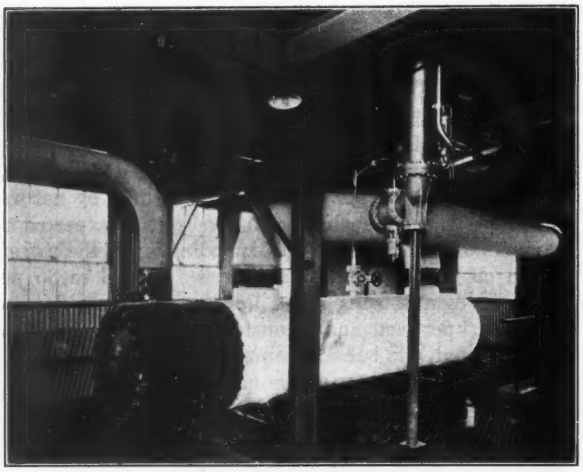


FIG. 4. THE STEAM REHEATER IS LOCATED ABOVE THE BOILER AND DRAINS BY GRAVITY TO THE BOILER DRUM

with a total surface of 2060 sq. ft. High pressure steam makes two passes through these tubes and heats 196,000 lb. of steam per hr. 190 lb. pressure from about 60 deg. to a final temperature of 575 deg. F. The reheater will use approximately 19,000 lb. of saturated steam per hour.

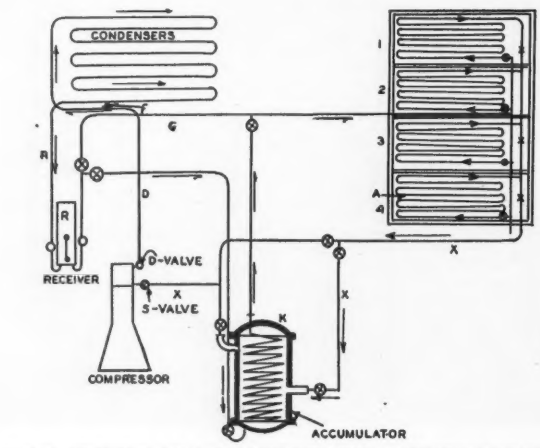
The boiler feed pumps consist of two 4-in., 7-stage, 3550-r.p.m., vertically-split units with a capacity of 600 g.p.m., each of 337 deg. F. water against a total head of 3630 ft. Under these conditions the efficiency will be 55.5 per cent.

Accumulators for Refrigeration Systems

By Gilbert Wray

ACCUMULATORS are built on somewhat the same plan as shell type brine coolers. In the past they were not, as a rule, installed when the plant was first built, but afterwards, usually after a compressor head or two had taken French leave.

Plants having long suction lines with many angles, bends and turns, which cannot be avoided because of building obstructions, have considerable trouble, especially when working under the wet system. The suction line gases are quite moist and tend to pocket and liquefy through the crooked sections. When a certain amount of ammonia is trapped, it is entrained by the suction gas and is carried over into the compressor with a terrific rush which may cause serious damage if the engineer does not happen to be on hand to shut down or slow up the machine.



CROSS SECTION OF AN ACCUMULATOR AND ITS LOCATION IN THE REFRIGERATION CYCLE

Sometimes gaskets or heads as well as discharge valves are blown out and heads cracked. This means a shutdown for repairs, usually in the hottest weather when the machine is needed most. Installing an accumulator does away with the above mentioned trouble and also increases plant efficiency.

Accumulators are built and installed to meet the system's requirements. On the average it is about the size of an ordinary brine cooler filled with 2-in. spiral coils entering at the bottom and coming out at the top of the shell. The suction line return from the house expansion coils enters the shell at from ½ to ⅔ of the distance down from top of accumulator.

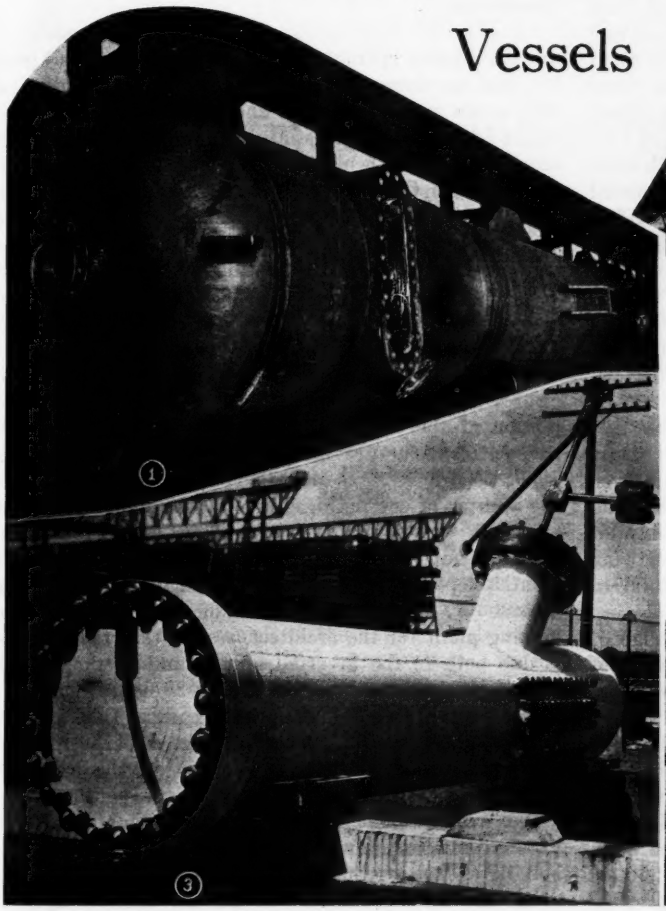
Spiral coils in the shell are a sectional part of the outgoing liquor lines to the expansion valves and the return suction gases, loaded beyond the saturation point enter the shell, and the liquid falls to the bottom of the accumulator. This continual operation causes an accumulation of liquor at the bottom of the shell and gives the equipment its name. This liquor is evaporated by the heat coming through the shell, so it is generally placed in the hottest part of engine room, usually about ⅔ of it in the hot basement in which are located steam condenser pumps and traps. The heat causes reëvaporation, which in turn gives a precooling effect on the liquor in coils leading to different sections of plant. This evaporation gives dry gas to outgoing suction line to compressor and eliminates the former trouble.

If ammonia condensers are somewhat overloaded and keep a warm return liquor to receivers, the accumulator will make up for this inefficiency by precooling the outgoing liquor to the system. Warm or hot liquor lines must be avoided in order to get good results in expansion coils.

A cross section of a typical accumulator and its position in the refrigeration cycle is shown by the accompanying sketch. In normal operation, liquor from the condenser passes to the receiver R through the accumulator K to the expansion coils A. The gas leaves the coils A and passes through the lines X to the accumulator and on to the compressor. Bypasses G and B are installed so that the accumulator can be cut out of service if desired.

Fifty-seven miles of wire to the pound is certainly drawing it fine. It is made of Konel, a nickel, cobalt, ferrotitanium alloy, 80, 20, 10, discovered by Dr. E. F. Lowry of Westinghouse Research Laboratory and used for filaments in radio tubes. The dimensions are 0.002 by 0.0005 in. with variation not over 0.0001 in. Tensile strength is 60,000 lb. per sq. in. at 1112 deg. F., nearly 1¾ that for chrome-nickel steel, which seems to promise usefulness in other fields such as Diesel engine valves and steam turbine blades.

Electric Welding Applications to Steam Pressure Vessels



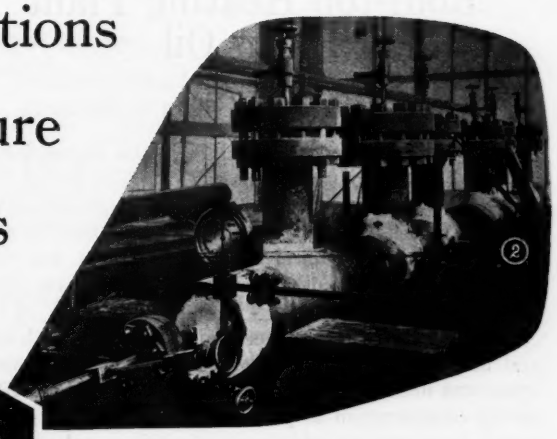
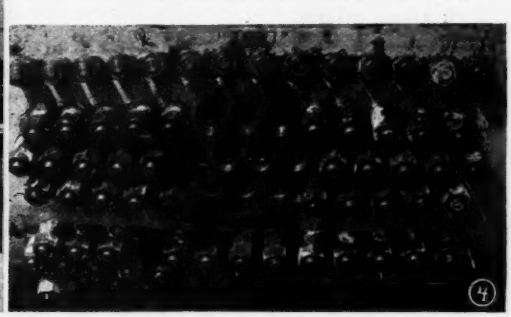


Fig. 1. Shell for a Steam Reheating Unit in the Deepwater station, Houston, Tex., designed and built for a steam pressure of 400 lb. per sq. in. in combination with a temperature of 750 deg. F.

Fig. 2. Steam Manifold for Deepwater station, Deepwater, N. J., under a hydrostatic test pressure of 4000 lb. per sq. in.

Fig. 3. Superheater Drum under hydrostatic pressure test. Drum is similar to those built for the Navy except one additional steam nozzle is omitted. Drum designed for a steam pressure of 300 lb. per sq. in. and superheat of 150 deg. F.

Fig. 4. Close-up view of the fractured tube ligament in the test drum of Fig. 3. Fracture occurred under a pressure of 2770 lb. per sq. in.



Photos by courtesy of A. O. Smith Corp.

ELECTRIC welding of steam piping and directly fired steam drums has now passed the experimental stage of development and during the past year and a half a number of noteworthy applications have been made in the power plant field. Much of the pioneer work with electric welding of pressure vessels has been done in the oil, gas and chemical industries so that extending the process to power plant equipment has met with unusually satisfactory results.

One recent application of electric welding is the shell for a steam reheater unit which is shown in Fig. 1. Four of these units have been constructed and the design was complicated because of concentrated loads in addition to the internal pressure and the desire for large rectangular openings to provide accessibility to the tube elements on the inside. Furthermore, the shell had to be built to exceptionally close tolerances due to the many high pressure steam connections as well as the desire for close clearances around the tube sheets and baffles.

Among the first applications of electric welding of pressure vessels was to power plant piping where its success soon extended its use to the construction of manifolds. The notable example shown in Fig. 2 was designed and constructed for a working steam pressure of 1350 lb. per sq. in. in combination with a maximum temperature of 750 deg. F. This type of construction permits a flexibility in design which casting does not and resistance to steam flow is also reported to be less than with cast manifolds.

Application of electric welding to direct fired steam drums was first made last year when superheater drums were built for installation on a U. S. Scout cruiser. At the time the drums were built, an extra one was also constructed for a demonstration destruction test, photographs of which are shown in Fig. 3 and 4.

As applications of welded equipment increase careful study of their success and comparisons with other methods of construction are being made to the end that engineers may choose the safest, most reliable and most economical methods available.

Roof-top Heating Plant Burns Oil

UNIQUE LOCATION RELEASES VALUABLE SALES SPACE IN BASEMENT. BY JOHN B. BEHRENDS

MODERN inventions and plans in this industrial age have literally turned the world upside down. They have actually turned the Eastern Outfitting Co. building in Los Angeles upside down insofar as the heating plant for that building is concerned, for the boilers, hot water heater and tank, and other heating equipment are placed on the roof thereof.

Julian Sieroty, the owner and manager of both store and building, decided that practically all the basement space was needed for sales and display purposes. After giving consideration to plans for a sub-basement, which would have cost an additional $40,000, to take care of the heating and hot water plant requirements, the designing engineer decided that the problem could best be solved by placing the heating plant on the roof. It has proved economical in operation and is a decided success.

The city building code of Los Angeles prescribes that business may not be conducted in any private structure at a height of more than 150 ft. above the ground level. In effect, the ruling limits the usable part of office and store buildings to about 13 stories. A penthouse, however, may continue upward 35 ft. more and advertising structures may add another 50 ft., making a total of 235 ft. above ground.

So a two-story penthouse, taking full advantage of the code, rises from the roof, giving the impression of two additional floors. The neon-lighted clock tower continues on up another 50 ft. Projecting even above this is a smokestack, emerging from the center of the clock tower, and supported by four braces. In placing the smokestack entirely above the service floors, the architect gained considerable space. The stack is 3 ft. 6 in. in diameter, and if it had been carried up from the basement would have occupied a total of more than 250 sq. ft. of floor space by passing through the intervening stories.

On the first floor of this penthouse are installed two steam boilers, one hot water furnace and tank, an air blower for atomizing the fuel oil, a water softener, salt tank, two pressure sprinkler tanks, the main switchboard, transformer vault and four garbage incinerators; there is besides, a ladies' rest room of considerable size.

Fuel oil is pumped from a 3000-gal. steel tank under the sidewalk outside the main wall of the store building. By means of two oil pumps, located in the basement, the fuel is piped to the boilers on the roof. There are also two condensation return pumps and a vacuum pump in this basement assembly, which takes up a space of 10 by 21 ft., releasing all the other space in the 160 by 112 ft. basement for other purposes, chiefly display and sales of household goods.

Steam generated on the roof is carried down through the various risers and the 316 steam radiators having 16,000 sq. ft. of radiation. The vacuum pump is driven by a 1½-hp. motor. The condensation is collected in a small tank in this basement room, thence pumped back into the boilers.

Two steam boilers are designed to burn either oil or gas fuel; the latter, however, as an emergency provision. Fuel oil of 23 deg. Baumé is used. The down feed risers connect with a welded distributing header across and above the front of the boiler. The hot water heater also is fitted for both oil and gas and is similarly operated. The entire heating and hot water equipment for this building is contained in a room 24 by 46 ft. in dimension.

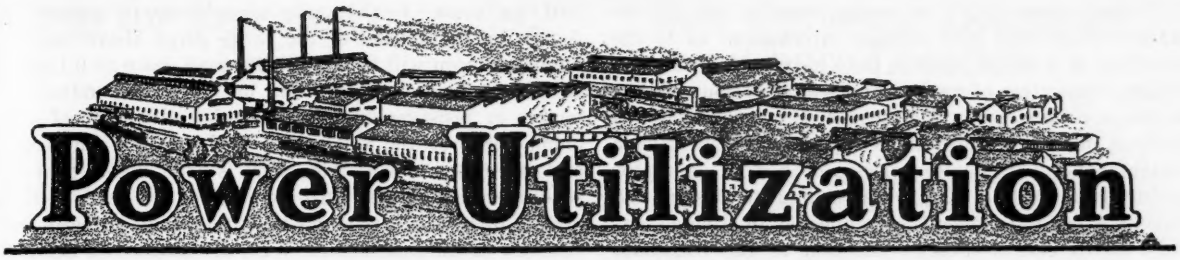
Also on the roof, mostly contained in the penthouse, are the regular sprinkler tanks, both pressure and gravity, and the domestic water supply for the building, as well as the ventilation fans and motors. The weight of water for fire and domestic use was what largely determined the strength of the structural steel entering into the Eastern Outfitting Co. building. So little extra weight was imposed by this elevated heating plant that no extra provisions were necessary for it.

Within the Eastern Outfitting Co. Building is space of approximately 825,000 cu. ft. that must be heated. The heating requirements were figured on a basis of raising the temperature inside to 70 deg. F., from a minimum outside temperature of 30 deg. F. Exact figures of fuel consumption have been kept since completion of the building in August, 1930. For heating this entire structure during the month of December, 1930, the fuel cost as stated by the chief engineer and the auditor of the building amounted to only $30.34, or less than one dollar per day. This low cost appears amazing but is in line with the costs of the previous months kept thus far as regards heating plant fuel expenses. F. M. Sterns, designer of the unique roof-top heating plant for the architect, asserts that the economy is due both to the inverted system and to the type of volatile fuel oil used, an oil testing 23 deg. Baumé.

As to the actual installation expense, this was, for the Eastern Outfitting Co. building, 4 per cent more than a heating and hot water plant in the basement. This extra cost is for piping oil to the penthouse, together with the machinery and motors for developing vacuum and returning the condensed steam back to the boilers, as well as the added work of placing the plant so far above the ground level. The store, however, saved the cost of digging a sub-basement, and gained needed sales space.

Building officials feel that the extra 4 per cent for roof installation is a small matter compared with the economies it invoked, having already more than paid for itself in reasonable fuel bills and by releasing the basement space for display and sales of house furnishings. The first basement has become important in retail shopping districts; it is easy of access and often customers will visit a basement where they will not take time to go to the higher sales floors of a building.

IN A FAMOUS eastern cathedral, snow removal from towers and roof to eliminate severe strain on the arches is to be accomplished by melting with steam. The piping system is to be completely enclosed in masonry and inaccessible after completion of the structure. All joints, fittings and bends are being made by oxy-acetylene welding, tested to 150-lb. water pressure and inspected for leaks, then enclosed beyond possibility of inspection or repair, which exemplifies the faith that the architects and builders have in the permanence of welding for pipe construction.



Electrical Maintenance Instruments

GROUNDS AND INSULATION TESTS WITH DISCUSSION OF METHODS AND INSTRUMENTS USED IN MAKING THEM. BY A. I. GREENWOOD

"CHIEF, that cable is shorted and grounded. What do you suppose can be the matter with it? We took every precaution in getting it in place. It must be there is a puncture at that low section that lies in wet ground. Every phase rings a short and rings to ground."

"Bill, I agree with you. I don't see how the cable can be bad but you examine it thoroughly and make sure none of those laborers stuck a pick into it."

Careful examination by Bill and his men reveals no visible evidence of injury to the cable. Finally it is decided to try applying 115 v., 60 cycles, to the cable. This shows clear. Next 460 v. is tried with similar results. Next 2300 v., which is the rating of the cable, is applied without any evidence of a fault.

Why did the magneto ringer show a short when the regular line voltage showed the cable to be all right? This is the why. The cable was a three-conductor, lead-covered cable and had sufficient capacity between phases to allow a high-tension magneto to send through current to ring the bell. This brings up the following question: If a magneto ringer is not good for testing insulation and continuity of a circuit, what is?

Not so many years ago a magneto, a battery ringer or a test lamp was the sole testing equipment of the average electrician doing electrical inspection and maintenance. The magneto ringer is an old friend that is hard for the old time electrician to give up but really there is little excuse for using one in a modern plant. A "high-tension" magneto has a resistance of about 5000 ohms and will ring through an external resistance of about 40,000 ohms. This makes it suitable for continuity tests in the average circuit found around an industrial plant, where the highest resistance probably encountered will be 440-v. contactor coils. These may run as high as 2000 to 4000 ohms. But a simple continuity test is usually insufficient to locate trouble.

That the results obtained are indefinite is the chief objection to using a magneto. The indication may be that a circuit is open or that it is continuous but there is no way of knowing the resistance value. If capacity exists in a circuit, a magneto will give results entirely erroneous, as indicated above. A 5000-ohm ringer will ring through a capacity of about 0.1 microfarad, which is equivalent to about 600 ft. of 350,000-circular mil, three-conductor cable. It is evident then, that, if a ringer is to be used its limitations should be fully understood. A low-voltage, low-resistance ringer operated by a battery is suitable only for testing circuits of low resistance, a sphere of usefulness indeed limited.

FIG. 1. RINGER MAGNETO GIVES INDEFINITE RESULTS. FIG. 2. PORTABLE WHEATSTONE BRIDGE GIVES ACCURATE RESISTANCE MEASUREMENTS BUT NEEDS EXTERNAL DRY CELL. FIG. 3. PORTABLE MEGGER MEASURES 10,000 OHMS TO 100 MEGOHMS. FIG. 4. OHMMETER READS 0.1 OHM TO 10,000 OHMS. 3 AND 4 WITH POCKET VOLTMETER ARE IDEAL FOR MAINTENANCE

Today, many types of testing devices are on the market which will give definite information as to the condition of a circuit, such as the "megger," wheatstone bridge, ohmmeters of various types and, of course, voltmeters and ammeters. The megger or megohm-meter is perhaps one of the most convenient and useful of such instruments. This device consists of a d. c. generator giving from 250 to 1000 v. according to design and having a moving element so connected in divided circuits as to give a direct indication of the resistance being measured. It can be purchased in different types and with different scales, a convenient type for general use about an industrial plant being an instrument which reads from 10,000 ohms to about 100 megohms, Fig. 3. This is a portable type and weighs only about 7 lb. as compared to 17 lb. for a high-tension magneto. For use in a shop and for special equipment, it is well to have a larger model with a higher range, giving readings from say 4 megohms to 2000 megohms.

Accurate Resistance Measurement

Primarily a megger is supposed to be used to measure insulation resistance and for this work it is unexcelled. We have found, however, that the small portable instrument is convenient for testing circuits for shorts, opens or grounds. After testing with a megger the electrician has much more definite information as to the condition of the circuit than when a ringer is used. Another advantage of the megger is that it operates on direct current hence gives no false indications when the circuit contains capacity.

Many times when trying to locate trouble in a machine or device, it is desirable to know more about the circuit than simply whether it is open, shorted or grounded. It may be necessary to have an idea of the resistance of various parts of the circuit. For this purpose the wheatstone bridge, Fig. 2, is the most common form of tester but recently a simpler and more convenient type of instrument known as the ohmmeter has come on the market. For accurate measurements the wheatstone bridge is the standard. It can be used for measuring resistance values from about 0.01 ohm to 100,000 ohms, and will give an accuracy of probably about one-tenth of one per cent. When measuring circuits of low resistance, the resistance of the connecting leads should be measured and subtracted from the readings obtained in the test. For measuring resistance of less than 0.01 ohm, the Kelvin bridge should be used but, as such measurements are seldom necessary in an industrial plant, this device cannot be considered as essential equipment.

For approximate and quick indications of resistance, probably the most useful instrument is some form of ohmmeter. Some designs employ a self-contained generator and some a self-contained dry cell. The latter is the more convenient and should be accurate enough for ordinary trouble shooting. One of the latest models has a zero adjustment to compensate for variation in battery voltage and has two scales giving a total range of from one ohm to about 50,000 ohms. In our own shop we have a homemade tester of this type which gives readings from about 0.1 ohm to 10,000 ohms, which we have found a more practical range for our needs. This homemade tester, Fig. 4, with self-contained No. 6 dry cell weighs about 5 lb. The commercial product weighs about half that much. To the writer's knowledge no ohmmeter is now on the market of the range given above but no doubt one soon will be. Ability to read down to 0.1 ohm is useful when testing rotors or stators of induction motors or resistance grids. The chief advantage of the ohmmeter over the wheatstone bridge is its simplicity and ease of operation. Also there is little chance of misreading an ohmmeter. Just connect the two leads to the circuit to be measured and read the result directly on the scale of the instrument. With the wheatstone bridge, various switches on the instrument must be in certain positions. Then a balance must be obtained by turning dials to various values of resistance. An additional drawback is the fact that few models are arranged for a self-contained battery.

For general resistance testing an ideal combination would seem to be: An ohmmeter range 0.1 ohm to 10,000 ohms and a portable megger having a range of 10,000 ohms to 100 megohms. Both these instruments together will weigh no more, nor take up more space than the old-fashioned magneto and will give accurate information as to the condition of the circuit.

In doing maintenance work around an industrial plant, it is often more convenient to make tests with power applied, usually where a short or a ground is not involved but the apparatus functions badly. For such testing, voltmeters, ammeters or wattmeters are used. A voltmeter is probably the most useful instrument in this class. It can be used for testing line voltage or voltage across various parts of a circuit.

For testing line voltages and for checking a supposedly dead circuit as a safety precaution, the pocket voltage tester is useful, of which several types are on the market. One of the best for circuits up to 500 v. is a magnetic type with indicator showing approximate voltage. Alternating current is indicated by vibration of the tester. This device is much safer than the old-fashioned test lamp and is more compact. Every maintenance man should carry such a tester in his pocket, so that it will always be available when needed. For testing of 2300-v. circuits, a potential transformer with a lamp in the secondary circuit makes a convenient arrangement.

For indicating live conductors of 440 v. or above, a neon tube type of tester is most useful. This is about the size of a fountain pen and can easily be carried in the pocket.

For lubricating open gears, G. H. Olson, manager of the Crane and Shovel division, Link-Belt Co., states that operators of cranes, excavating and other machinery will find the following an efficient mixture: White Lead ½ lb., Cylinder Oil ½ gal., Flake Graphite ½ lb.

As this mixture adheres well to the gears it can be painted on with a brush, as required, at intervals of about 5 hr.

Cup grease may be substituted for the cylinder oil. The graphite may be omitted, but it is not advisable to do so in warm weather. The white lead mixture may be made heavier for warm weather by using less oil or grease in proportion to the quantity of flake graphite.

Above all, keep all moving parts properly lubricated for increased life and efficiency.

Trip for Remote-Controlled Switch

By Charles A. Peterson

RECENTLY the writer installed a two-pole single-throw, 2300-v. electrically-controlled switch handling a single-phase circuit to an electric furnace, rated 400-kv.a. The control circuit is 230-v. d.c. The switch was satisfactory in operation except that, in case of d.c. power failure, the 2300-v. switch, if in a closed position, could be opened only by sending an employe from the electric furnace room to trip out the switch manually. This was, of course, rather annoying and to overcome the difficulty, a d.c. solenoid was added so that in

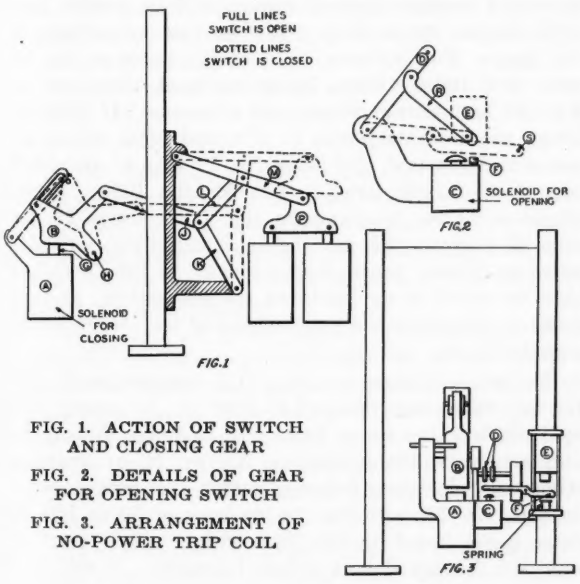


FIG. 1. ACTION OF SWITCH AND CLOSING GEAR

FIG. 2. DETAILS OF GEAR FOR OPENING SWITCH

FIG. 3. ARRANGEMENT OF NO-POWER TRIP COIL

case of d.c. power failure, its armature drops, tripping out the switch.

Three sketches show the relative location of the various parts. The following description of the operation of the switch will make it clear to the reader. When solenoid A, Fig. 1, is energized, the armature G rising, moves the casting B upward about center H and, by means of the various levers, closes the switch, the toggle levers marked D and R on Fig. 2, not shown on Fig. 1, holding the switch in a closed position after solenoid A is deënergized. To open the switch, solenoid C, Fig. 2, is energized, its armature rises and the jackknife action of the toggles, D and R, opens the switch, as point marked S is connected to K and L of Fig. 1 by a rod.

Solenoid E, Fig. 3, also trips out the switch by its armature acting through trigger F on levers D and R in the same manner as the armature of coil C. The solenoid E carries direct current continually except when a power failure takes place; when such failure occurs, the armature drops on the trigger, rebound being taken care of by springs below the trigger.

The device has functioned perfectly since its installation and has saved us a lot of trouble.

Belt Conveyor Discharge Chute Location

TO locate correctly the chute which is to receive the discharge from a belt conveyor, the path that material will take under the forces of belt speed and gravity, as well as diameter of the head pulley must be taken into account. As formulas to determine this trajectory or parabolic path are somewhat complicated, the chart, Fig. 1, has been worked out by Link-Belt Co.

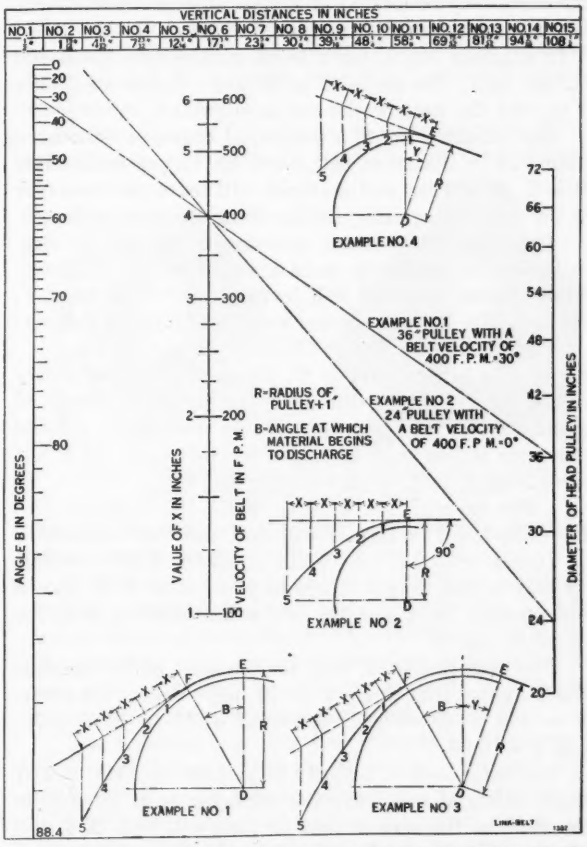

VERTICAL DISTANCES IN INCHES
NO.1 NO 2 NO 3 NO 4 NO 5 NO 6 NO 7 NO 8 NO 9 NO. 10 NO 11 NO 12 NO 13 NO 14 NO 15
ANGLE B IN DEGREES
VALUE OF X IN INCHES
VELOCITY OF BELT IN F. P. M.
DIAMETER OF HEAD PULLEY IN INCHES
R=RADIUS OF PULLEY+1
B-ANGLE AT WHICH MATERIAL BEGINS TO DISCHARGE
EXAMPLE NO.4
EXAMPLE NO 1
36" PULLEY WITH A BELT VELOCITY OF 400 F. P. M. 30°
EXAMPLE NO 2
24" PULLEY WITH A BELT VELOCITY OF 400 F. P. M. 0°
EXAMPLE NO 1
EXAMPLE NO 2
EXAMPLE NO 3
LINK-BELT

CHART FOR LOCATING CHUTE TO RECEIVE DISCHARGE FROM BELT CONVEYOR

of Chicago to give a convenient method of determination.

On the right-hand scale are diameters in inches of head pulleys. The middle scale is for conveyor belt velocities in feet per minute, also values of X whose use will appear later. At the left is a scale for the values of angle B, as in example No. 1, between a vertical radius and the point where material leaves the belt. A straightedge laid across the three scales gives values corresponding to any set of conditions. As for instance with a head pulley 36 in. diam. and belt speed of 400 ft. a min. angle B will be 30 deg. Where the line would cut the left-hand scale of 0 deg. or less, it means that material will leave the belt at the top of the pulley or at E in example No. 1.

To determine the path of the material: To a line representing the center line of the conveyor as it approaches the head pulley, erect a perpendicular D E with length equal to the head pulley radius plus 1 in.

Describe arc E F and make angle B that given by the left-hand vertical scale. At F, draw a line tangent to arc E F, i.e. perpendicular to D F.

Divide this tangent, starting at F, into sections, each representing the length of the value X as shown by the middle vertical scale, drawn to the same scale as that for the head pulley diameter. From each division point drop a vertical line and lay off distances as shown in the table at the top of the chart; for point 1, ½ in.; for point 2, 1$\frac{5}{16}$ in. and so on. The line 1, 2, 3, 4, 5 will show the path of material after leaving the conveyor belt and the chute may be located at any point where it will clear the belt and intercept this path.

In example No. 1, for a 36-in. pulley, belt speed 400 ft. per min., the angle B is 30 deg. Values of X are 4 in. and the path works out as shown.

For example No. 2, a horizontal conveyor with head pulley 24 in. diameter, belt speed 400 ft. per min., angle B is 0, X is 4 in. and material will leave the conveyor at the top of the pulley, falling along the path indicated.

Example No. 3 is for a conveyor inclined 20 deg. to horizontal, otherwise as in example No. 1. To determine whether material will leave the belt at E or at F, example No. 3, an indicator must be found as follows:

$$\text{Indicator} = V^2 \div (32.16 \times R \times \text{Cos } Y)$$

where V is belt velocity in ft. per sec.; R is head-pulley radius plus 1 in., reduced to ft.; Y is the angle of inclination of the conveyor to the horizontal. If the indicator is less than 1, trajectory will begin at F.; if more than 1, at E as in example No. 4.

For example No. 3, $V = 400 \div 60 = 6.67$; $R = (18+1) \div 12 = 1.58$; Y=20 deg. and Cos Y=0.94.

Indicator $= 6.67^2 \div (32.16 \times 1.58 \times 0.94) = 0.938$. As this is less than 1, trajectory starts at F as shown for example No. 3 and the rest of the solution is as for example No. 1.

For example No. 4, data are the same as for example No. 2 except that angle Y is 20 deg. Values are then: $V = 400 \div 60 = 6.67$; $R = (12 + 1) \div 12 = 1.08$; Cos Y = 0.94.

Indicator $= 6.67^2 \div (32.16 \times 1.08 \times 0.94) = 1.37$ hence material will leave the conveyor at E, 20 deg. to the right of the vertical and its path will be 1, 2, 3, 4, 5 of example No. 4. Location of the chute should, evidently, be different from that for example No. 2.

Clean Lights and Ample Wiring for Effective Illumination*

By Walter Sturrock**

DUST AND DIRT accumulate on all fixtures, indirect and semi-indirect being generally the worst collectors. Tests of the light output before and after cleaning of a semi-indirect enclosed unit, which had accumulated dirt for several weeks showed one-third the light lost by dirt on the fixture. For direct units and closed globes, washing with soap and water is recommended as follows: Very dirty locations, every 7 days; dirty, every 15 days; average, every 30 days; clean, every 30 days. For open top units, in average and clean surroundings, washing should be twice as often.

Enclosure of lamps does not, as is sometimes supposed, decrease lamp life, provided the fixture surface is sufficient to radiate heat so that temperature rise will be normal.

Typically, out of 100 Mazda lamps, 8 will be burned out after 600 hr., 28 after 800 hr. and 54 after 1000 hr. of use. Many of those still working after 1000 hr. will be at low intensity and should be replaced.

Wiring for Good Light

Code regulations as to wiring, either national or municipal, insure protection from fire hazard but not lighting economy. Today, illumination of 15 to 18 foot-candles are being used as against 10 to 12 a few years ago. If larger lamps are used on an old system, light is wasted because drop of voltage will be greater and light output drops three times as fast as voltage at the lamps. For instance, on a 75-ft. circuit of No. 14 wire, if 6 100-w., 115-v. lamps are used, drop will be 2 v. and light output 94 per cent of normal. If 6 300-w. lamps are used, drop will be 6 v. and light output 84 per cent of normal. By using No. 10 wire at an added cost of $5 to $6, light output for the 100-w. lamps would be 98 per cent and for the 300-w. lamps 93 per cent of normal. To get the increased light now demanded, it may prove good economy to rewire rather than to install more lights on the old system, as that tends to aggravate the poor output of the larger lamps already in use.

To insure adequate wiring, it is recommended that for branch circuits limited to 1000 w., to supply 400 sq. ft. of working space, 800 sq. ft. hallways, 600 sq. ft. auditoriums and hospitals, or 200 sq. ft. of drawing rooms, also for runs between outlets the smallest wire used be No. 12, with No. 10 for runs of 50 to 100 ft. from panel board to the first outlet. Such runs of over 100 ft. should be avoided if possible; if not, load should be limited to 600 w. on that circuit and area supplied reduced to 60 per cent of figures given above.

Convenience outlets should be on separate circuits not over 10 to a circuit and for such services as doctors, dentists and barbers not over 2 per circuit. Wire for runs up to 100 ft. should be at least No. 12 and for over 100 ft. No. 10.

Panelboards should have one spare circuit for each 5 service circuits, preferably with a switch for each circuit in addition to fuses.

Feeders should cause drop of not over 2 per cent from service entrance to panelboard on the basis of 7½ amp. at 115 v. to be supplied to each 15-amp. branch circuit position on panelboards. Conduits and ducts should be of size to allow replacing conductors with those two gages larger or 50 per cent greater capacity. If no conduits or ducts are used, it is best to give the original installation the added 50 per cent capacity.

To prevent direct contact between a moving part and its support is the first function of a lubricant. After that, minimum of friction and of change from air conditions, also freedom from corrosive action on metals are desired qualities.

*From a paper before the National Industrial Congress, at Cleveland, Ohio.

**Illuminating Engineer, General Electric Co., Nela Park, Cleveland, Ohio.

Economic Industrial Lighting Upkeep*

By R. C. Smith**

As a result of tests carried on over a period of 44 weeks under plant lighting conditions, covering locations of clean air, light dust, heavy dust and fumes, conclusions were reached that for glas-steel diffusers, cleaning with a solution of trisodium-phosphate was the most effective method. Dry cleaning served fairly well in clean air and light dust but was only 50 per cent effective in the other locations.

From the curves of drop in illumination, it was determined that for heavy fumes and heavy dust, cleaning should be every 2 mo., for light dust every 3 mo. and for relatively clean air as in shop offices every 4 mo. While more frequent cleaning might increase average illumination, increase in production is not believed to warrant the expense.

Gain in illumination by substituting a new lamp for the old one after cleaning at the end of 22 weeks was not sufficient to be of consequence.

After cleaning, however, lamp depreciation came to have a noticeable effect and in 8 to 12 weeks the illumination fell to that just before cleaning. At the end of the second 22-week period, illumination had declined so that cleaning barely brought it back to the value just before the first cleaning.

Tests are still under way to determine the relative economy of replacing each lamp as it burns out as against replacing all lamps in each four-lamp group when any one of them burns out, the latter being on the basis that the other three lamps are probably nearing the end of their useful life. So far there seems little difference in illumination but total cost per fixture is larger on the four-lamp method.

As to replacement before actual burnout, curves projected over a period of a year show that with cleaning every 4 mo., if old lamps are carried to the end of the year, lighting efficiency will decline steadily after 2 mo. so that at the end of the year it will be 48 per cent its average value and will be below 90 per cent for 8 mo. and below 70 per cent for 4 mo. out of 12. If lamps be renewed at the end of 7 mo., average lighting efficiency will be maintained at 95 throughout the year and will be below 90 per cent for only 4 mo. of 12, being at 70 per cent at the end of 7 mo. and 78 per cent at the end of the year, never below 70 per cent.

Above results will serve as a guide in formulating routine to secure the lighting needed for best production at the lowest cost. While it had no particular bearing on the comparative test results, the fixtures were so spaced as to give 1 w. per sq. ft. with 100-watt lamps and initial illumination was 10 and 10½ ft.-candles at test positions.

*From a paper before the National Industrial Congress, Cleveland, Ohio.

**Illumination Standards Dept., Western Electric Co.

For chain grate stokers, arches are an important feature of furnace design. Properly designed, they aid ignition and counteract the tendency toward gas stratification.

Growlers Locate Faults in Windings

By means of the Growlers shown in the accompanying illustrations and which have been developed and placed on the market recently by the Ideal Commutator Dresser Co. of Sycamore, Ill., it is a simple matter to locate "shorts," "grounds" and "opens" in armatures, stators and coils.

These Growlers are made in two types for use on armatures and stators of the smallest motors and generators to the largest. The adjustable feature makes them adaptable to various slots and proper span of coils of armature or stator being tested. The Growler windings are enclosed in a metal case for protection against mechanical injury.

Essentially the Growler is an open magnetic circuit transformer with primary only (the wire on the iron

FIG. 1. SHOWING INTERNAL GROWLER IN USE
FIG. 2. EXTERNAL GROWLER IN USE

core of the armature or stator coil acting as secondary when magnet circuit is closed).

A hack saw blade is the only auxiliary equipment needed to accurately locate the defective coils. In addition to locating grounds, etc., the Growlers can be used in connection with any meter, receiver or lamp test and may also be used for charging magnets and for demagnetizing tools or permanent magnets.

The external type Growler is made in five sizes for armatures from ¾ in. to 30 in. in diameter. It is hinged at base to permit adjustment for various sizes of armatures and makes perfect magnetic contact with armature without overhanging or protruding iron.

To test armatures, they are laid on the adjustable pole pieces of the Growler so that the Growler embraces them as closely as possible. The Growler current is then turned on and the armature turned around slowly by hand; a hack saw blade should be placed diametrically opposite center of space between jaws of Growler and slid back and forth, keeping it parallel with the slots in the armature. If a "shorted" coil is present, a heavy current will pass through it, causing the hack saw blade to be attracted which immediately indicates where the defective coil lies.

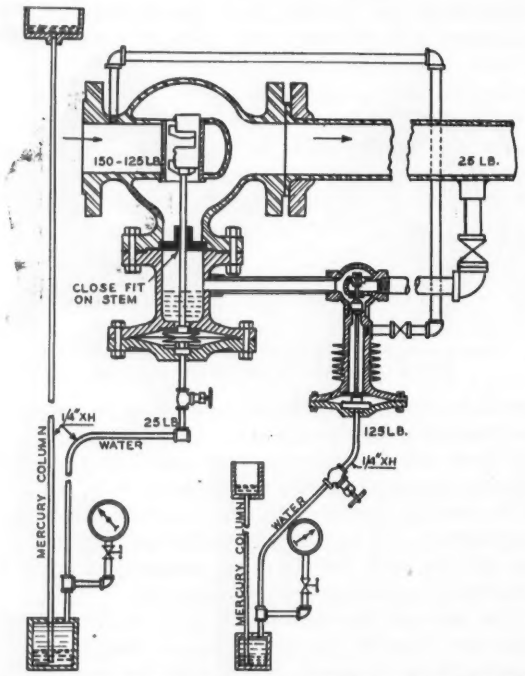
The internal type Growler for stators is made in two sizes. It can be used on stators with openings from 5½ in. to 60 in. in diameter.

To test a stator, the Growler is placed on the inside of stator as shown in illustration, spanning one to six slots, depending on width. Turn on current and place hack saw blade between jaws of Growler, closing the slot opening. If the saw blade vibrates, the coil is defective. Continue around in this manner until all coils have been tested.

Pilot Valve Controls Mercon Reducing Valve

FOR THE PURPOSE of preventing an excessive demand from lowering the initial or supply pressure below a fixed minimum, the Mercon Regulator Co., of Chicago has developed and placed on the market a Mercon reducing valve with a new pilot valve. The pilot valve functions when the supply pressure falls below a predetermined minimum and closes the reducing valve. The arrangement of this equipment is shown in the accompanying drawing.

Its use can, perhaps, best be understood by a typical application. Boilers in an industrial plant supply steam at an average of 150 lb. pressure to operate turbines or



MERCON CONSTANT REDUCED PRESSURE REGULATOR WITH LOW SUPPLY PRESSURE SHUTOFF

engines, pumps and other equipment. A large amount of steam is also used at irregular intervals for process work. For this purpose the pressure is reduced to 25 lb. by means of one or more regulators of the type shown. The boiler pressure must not go lower than 125 lb. or the operation of the power units will be seriously affected. The system shown permits only steam in excess of 125 lb. pressure passing to the low pressure system. A ½ or ¾-in. pressure connection transmits the reduced pressure of 25 lb. through the wide open pilot valve to the upper surface of the regulator diaphragm. The diaphragm is balanced by a mercury column of sufficient height to exert a pressure of 25 lb. on the lower surface. The regulator consequently operates in the usual way and maintains 25 lb. reduced pressure so long as the supply or boiler pressure is above 125 lb.

The diaphragm of the pilot valve is loaded by means of a mercury column, spring, or weight corresponding to the 125 lb. fixed minimum pressure to be maintained. Normally the pilot diaphragm is held down by pressure transmitted through a small pipe from the boiler or inlet side of the regulator, this pressure being sealed in by the valve plug seating on the lower seat ring. As soon as the supply pressure drops below 125 lb., the pilot diaphragm moves upward, the plug seats at its top and opens the lower seat so that steam at about 125 lb. pressure flows from the supply line through the pilot valve and back to the upper surface of the main regulator diaphragm, thereby forcing it down and closing the regulator. As the regulator closes, the supply pressure starts to rise. When it passes 125 lb. the pilot valve seats downward again, and normal operation of the regulator is resumed. By proper design of the pilot valve and by throttling the needle valves in the mercury connections, hunting and surging are prevented. The regulator closes only far enough to prevent the supply pressure going below 125 lb., but of course with this restriction the reduced pressure may drop below 25 lb., until the demand is less or until the boiler pressure rises and stays above 125 lb.

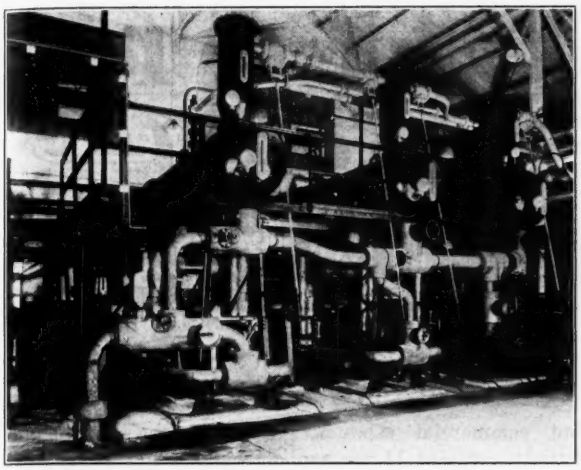
Other applications of this device are for plants having high-pressure and low-pressure boiler systems, where the excess of high-pressure steam may be used in the low-pressure system but it is desired to prevent the demands of the latter lowering unduly the high pressure. Another application is on gas distribution systems where a consumer must be prevented from lowering the distribution pressure to the detriment of other consumers.

Improved Production of Lubricating Oils

RESEARCH on the production of lubricating oils from paraffine base crude has led to the adoption of the Edeleanu process by the Bayonne refinery of the Tide Water Oil Co. This process is based upon the selective solvent action of pure liquid sulphur dioxide which has the property of completely dissolving those compounds in petroleum distillates which are most susceptible to decomposition and oxidation in service. The paraffine and naphthene hydrocarbons, the most serviceable and efficient lubricating compounds in petroleum oil, are insoluble in the solvent at low temperatures. The removal of the easily oxidized and sludge-forming compounds makes Edeleanu treated oils especially desirable for lubricating high speed turbines and engines where conditions conducive to rapid oxidation prevail.

Undesirable material is removed without any chemical reaction taking place between the sulphur dioxide and the oil. The complete removal of undesirable material by physical solution without the formation of soluble, easily-decomposed compounds results in oils having a high degree of resistance to sludge and emulsion formation, to decomposition by heat and to the formation of organic acidity.

The plant recently installed by the Tide Water Oil Co., at Bayonne, was designed especially for the treatment of lubricating oils. The stock to be treated at this refinery is not a crude oil but a carefully refined lubricating fraction which has already undergone the usual refining processes. The Edeleanu treatment is an extra step in the refinement designed to produce a product of a quality obtainable by no other means.



A SECTION OF THE TIDE WATER OIL CO. REFINERY

In the Bayonne plant, the sulphur dioxide and oil are thoroughly mixed by motor-driven paddles in a small mixer and the resultant mixture passes to a separator in which a rapid gravity separation takes place due to the difference in density between the two phases. In order to obtain greater efficiency, four mixers and separators are connected in series and the oil and solvent enter at opposite ends of the system and continuously pass through countercurrently. By this means. the oil is subjected to four treatments, in the first three mixers meeting the used solvent from the preceding separator and in the fourth meeting a stream of fresh sulphur dioxide which removes the last trace of impurities.

The refined oil leaving the mixing system contains a small amount of solvent which is removed in a series of evaporators. Since sulphur dioxide boils at 14 deg. F., it is easily and rapidly removed by vacuum distillation. The spent solvent is likewise pumped to a battery of evaporators where the sulphur dioxide is boiled off, leaving the impurities as a residue. All the solvent vapors from the various evaporators are collected, compressed, condensed to a liquid and used again in the system. The extract is used as a fuel oil. As the finishing step in the processing of Edeleanu-treated oils, they are subjected to filtration through fullers' earth. Filtration improves the emulsion characteristics of the oil and imparts a pleasing light color to the finished product.

Chain Grate Stoker for 100 to 250 Hp.

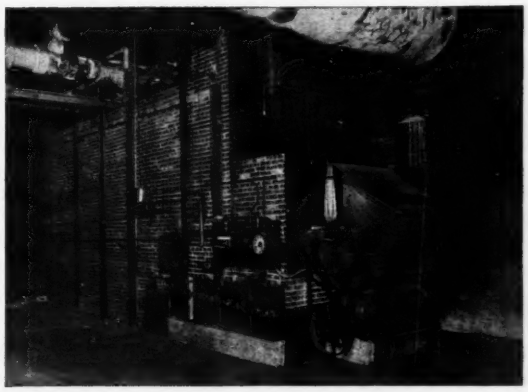
CHAIN GRATE STOKER in sizes suitable for use in schools, smaller offices, apartments. and similar installations, the new Illinois Junior stoker, designed for boilers in the 100 to 250-hp. range, has recently been placed on the market by the Illinois Stoker Co. of Alton, Ill. This stoker is designed to comply with every requirement for automatic operation. The new unit is designed so that coal is continuously fed to the grate from the feed hopper and then passes under feed gate adjustable to any height within 12 in. of the grate. This adjustment, together with the various speeds at which the grate can be run, is intended to make it possible to feed a continuous, even bed of coal of the desired thickness and quantity to the furnace. Due to the air control in both the forced and natural draft types, it is claimed, fuel is completely and efficiently burned by the time the rear or dumping end of the grate is reached. The fuel bed, during combustion, is not disturbed, consequently there is no opportunity, it is stated, for the formation of large clinkers. Ash and refuse are discharged by gravity.

The unit is built so that, as the chain passes around the rear drums and front sprockets of the stoker, each row of links rotates slightly with respect to the adjacent rows, to shear off any foreign material that has become lodged between the links.

Air control, both in quantity and distribution, is provided by the Illinois damper system. At the front end of the grate, the dampers are designed to supply this part of the grate with the largest percentage of the total air required. As the grate moves toward the rear or dumping end, and the volatiles and carbon enter the successive stages of progressive combustion, the air supply is proportionately decreased until the dumping end of the grate is reached.

The Junior Stoker has a height from top to bottom chain strands of 14 in., making it adaptable for use with low set boilers. The drive is the same on both natural and forced draft types; a double worm and gear reduction, embodying a shear pin device and two-way thrust cap. All gears have cut teeth, are running in oil, and are provided with dustproof covers.

In the forced draft type, a small exhaust fan draws air from the boiler room through the front casing of the stoker and into a special air chamber immediately behind the front drive sprockets. This air passes through



GENERAL VIEW OF ILLINOIS JUNIOR STOKER

the grate links to cool them before they re-enter the furnace. Dust covers throughout, riding seals, return skids, and heavily ribbed side frames, are other features.

The new stoker is equipped with a variable speed pulley. Both forced draft and natural draft stokers are operated by a 900-r.p.m. constant speed motor, belted through a Horton Variable Speed pulley, to allow a reduction in speed of from 50 to 75 per cent.

The difference between the Illinois Junior forced draft and natural draft stoker is that the front riding seals, bottom seal plates, and dust cover are omitted on the natural draft type and links with greater air spaces are used. The maximum size "Junior" stoker is 4 ft. 6 in. wide by 9 ft. 8 in. long; it can be installed under 5-ft. settings.

Fire Clay Mixtures

THERE ARE two items with which I disagree in the article on fire clay mixtures by P. F. Rogers on page 572 of the May 15, 1931, issue.

Some years ago, I made a number of fusion tests for a fire brick maker in St. Louis and found that the so-called flint clay, which is 98 per cent silica and diaspore (which is correspondingly high in alumina) are infusible in anything but the electric furnace or the acetylene torch; but, as the proportions of silica and alumina approach each other, the fusibility increases up to a certain point and then the mixture becomes more resistant. The curve as plotted resembles the letter W, the middle point being lower than the ends. The most resistant single clay that we found had a composition of 43 per cent alumina, 38 per cent silica, 1 per cent titanium oxide (a constant condition in Missouri clays and of no commercial importance), 2 per cent or 3 per cent of lime, iron and magnesia and the rest, water of composition. This made a fire brick, which was hard enough for buildings or sidewalks and could be handled like paving blocks.

Such clays as he describes, while highly infusible, are always deficient in strength after burning; at least, such has been my experience with Missouri, Ohio and Colorado clays.

The other point is the use of silicate of soda or water glass in cements. We had to line a 400-ft. kiln, the upper part of which reached 2500 deg. or more, and the lower part, less than 300 deg. F. The problem was to produce a cement which held equally well hot or cold. After a number of trials, I plugged a mixture of local clay and sand with just enough silicate of soda to make a stiff putty. This was dampened and applied. Experimentally, we built a small shaft furnace and burned coke with compressed air till we got pyrometer readings as high as 3200 deg. F.

As silicate of soda dissociates at 3100 deg. F., I was curious to know why the cement was not blown out, so made a number of test pieces by cementing two half bricks together and placing them in the hottest part of the furnace. They came out with the cement in a state of slag, showing that the soda had been volatilized and the silicic acid had grabbed new partners. Salt has a similar effect, combining with the silica and disengaging its chlorine. Lime is bad because silicate of lime is almost as fusible as silicate of iron, the ordinary slag of the copper smelters. Asbestos and graphite are infusible, but commercial asbestos, unless of the hornblende variety contains 14 per cent of water which is released at a red heat and ruins the bonding value. Ground bats, or grog, as we call it, is no better than sand and requires more silicate to pug properly. Its bonding value has been destroyed when crushed after vitrification.

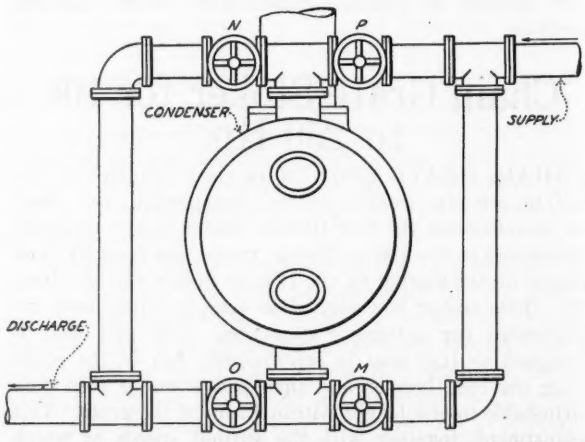
We used 6 per cent of a 33 deg. Beaume silicate of soda, which is equivalent to about 2 per cent of solid silicate. The clay and sand were damp before this was added, and the pug mill run long enough to mix and incorporate thoroughly.

Cleveland, O. L. R. BAKER.

Condenser Cooling Water Flow Alternated

COOLING water circulating through a surface condenser serving a compound engine was so heavily impregnated with mineral matter that it formed a soft friable scale. The tubes filled up so rapidly that they had to be bored out at the end of each week's run. When the weekly run was started, the vacuum gage would show close to 27 in., but, at the finish, the needle usually stood at about 10 in.

Observing that the scale was formed principally near the inlet end of the tubes, while the passage was practically clear at the outlet end, the engineer hit upon the idea of alternating the direction of flow from day to day, hoping thus to dislodge and wash out each day's deposit of scale-forming matter before it had time to



CROSS CONNECTION PERMITS ALTERNATING FLOW OF COOLING WATER

set. He cross-connected the supply and discharge piping as shown in the accompanying sketch.

Condenser tubes were arranged in two banks,—an upper and a lower. By keeping valves M and N open and O and P closed during one day's run, the inflow would be through the lower bank and the outflow through the upper. Then by keeping valves O and P open and M and N closed during the next day's run, the flow would be reversed.

The scheme worked so well that intervals between tube-borings were lengthened to a month or more, the vacuum holding well above 20 in. meanwhile.

St. Louis, Mo. D. J. ALTIZER.

Explosions and Wear in Air Compressors

EXPLOSIONS in air compressors do, unfortunately, occur at times, with more or less serious results. The cause of these explosions is usually due to the ignition of oil vapor in the compressor, owing to a sudden temperature rise in the compressor. The presence of dust in the intake air increases the liability to explosion and it also serves to block up the passage ways. It has been found that explosions have been frequent in compressors situated around collieries, this probably having been due to the presence of coal dust in the air. This shows the necessity of filtering the air as it is drawn into the compressor, to remove all dust.

Dust causes increased wear on the valves, passageways, pistons, etc., and should be excluded.

Another possible cause is excessive cylinder lubrication; only the best compressor cylinder oil with a high flash and ignition temperature should be used and even this should be used sparingly. Some engineers adopt the policy of lubricating running compressors with soapy water. The lubricant is made by adding soft soap to water until as much has been added as can be readily absorbed. Oil is used when starting up, but after a short time the oil is turned off and the soapy water turned on. This is done by having two lubricators connected to each cylinder, one being for oil and one for water. Soapy water can be fed through an ordinary oil lubricator; it is fed at the same rate as oil. This has been found to give excellent results, the only precaution necessary being to revert to oil lubrication at least one hour before stopping to prevent rusting.

This plan reduces the amount of oil fed into the compressor, which reduces the risk of explosion and reduce the rate of carbonization. Excess wear on the moving parts is due mainly to grit in the air, if absolutely pure air were used the wear would be small.

Although filtering the incoming air will greatly reduce the impurities contained, rust developed within the compressor may cause wear. I once had a 3-stage compressor which showed severe wear in the second and third stages. This was finally traced to rusting having occurred in the purge pots. After these were cleaned and given an internal coat of stove enamel, the wear was stopped.

When operating compressors, attention should always be paid to efficient draining between stages, as if water collects in the purge pots it may lead to rusting or moisture may be carried away with the rushing air.

Herts, England. W. E. WARNER.

Outboard Motor Bearings

SEVERAL of our clients have made inquiry as to practice on the use of third outboard bearings for motors, hence it is evident that the limits are not well understood.

A leading manufacturer of motors gives the following limits: For belted motors, the limits for two-bearing type are: 1800 r.p.m., 40 hp.; 1200 r.p.m., 75 hp.; 900 r.p.m., 125 hp. For silent chain drive, 1800 r.p.m., 5 hp.; 1200 r.p.m., 25 hp.; 900 r.p.m., 50 hp. With us the use of a 75-hp. motor with silent chain drive often comes up for gin applications. From the above figures, a two-bearing motor could be used with belt drive but not for chain drive. Two reasons for using the outboard bearing or chain drive are: First, the small diameter of the pinion sprocket on the motor and large speed reduction which makes the pull on the shaft about three times that with a flat pulley drive. This would result in a deflected shaft and rapid wear on chain and sprockets unless outboard support is given. The second reason is that, since the chain cannot slip, any jerk from starting or irregularity of the load will be transmitted to the motor shaft, causing a greater strain, especially at high speeds, than with belting which can slip and stretch.

This is no argument against silent chain drive, since high speed ratio and positive drive are among its advantages, but is a precaution to ensure that best results are obtained when using such drives.

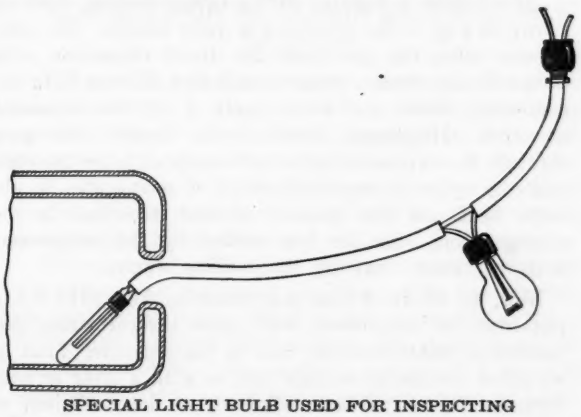
San Antonio, Texas. R. H. PARRISH.

Inspection Light for Small Openings

WHEN A WATER leak occurred in one cylinder of a gas engine, it was hard to determine whether the cylinder head gasket was letting in the water or whether there was a crack in the cylinder.

It was so dark inside the cylinder that nothing could be seen when looking through the igniter opening, and enough light could not be reflected through the opening to make it possible to locate the trouble.

An ordinary electric light socket would go through the opening but the light bulb would not, so a long bottle-like electric bulb such as used in the red and



SPECIAL LIGHT BULB USED FOR INSPECTING

green signals on switchboards, was obtained from a local dealer, which readily went through the opening and made the interior of the cylinder as light as day, and the leak was easily located.

The type of bulb is illustrated herewith and as the

bulb was obtainable only at a voltage of 110, and the circuit voltage was 220, an ordinary 110-volt light was placed in series with the inspection light as shown.

Such a light will be found handy for lots of places, hard to illuminate in any other way.

Coffeyville, Kan. ARNOLD KING.

Explanation of Reversed Heat Cycle

IN THE April 15 issue, the question about compressing steam and about the reversed heat cycle for heating is interesting and although the compressed steam part was all right I was disappointed to find nothing said about the reversed cycle or heat pump. Both of these are subjects which are not of widespread application but which do sometimes fit in nicely. The steam compressor is used quite often but I do not know of any heat pumps used for heating in this country although

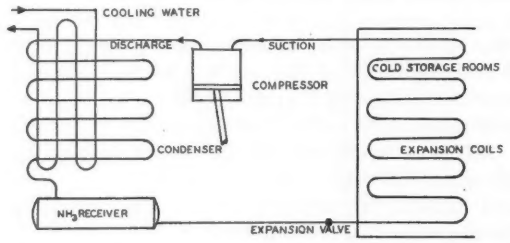


FIG. 1. DIAGRAM OF REFRIGERATION CYCLE

the industrial application seems to me to be quite practical under some conditions. I have been interested in it for some time in connection with considerable waste water we have which has some low level heat.

To understand the operation of this heat pump and how it is possible to get several times as much heat out of a machine as you put in, it is convenient to regard it as working on the regular refrigeration cycle. It is too bad that the word reversed go mixed up with it, I suppose that came about because the theoretical discussions go back to the Carnot cycle and the regular refrigeration cycle is a reversed Carnot cycle.

If we take a regular refrigeration system, such as shown in Fig. 1, the operation is quite simple. The compressor takes the gas from the direct expansion coils in the storage rooms, compresses it and delivers it to the condenser where the water cools it till the ammonia or other refrigerant liquefies; the liquid then goes through the expansion valve and evaporates in the coils and the cycle is repeated, when it evaporates it absorbs heat and the amount of heat absorbed in the storage room plus the heat added by the compressor must be taken away by the cooling water.

Now, we all know that a kilowatt-hour or 3412 B.t.u. put into the compressor will move several times this amount of heat from the cold to the hot side. That is, we get a certain advantage just as with a lever or pulleys and this advantage is known as the coefficient of performance (cop.), which, by the way, every ice plant operator should know for his plant. Theoretically this cop. for the Carnot cycle is

$$\text{cop.} = \frac{T_2}{T_1 - T_2}$$

Where the temperatures are expressed in degrees absolute, that is deg. F. plus 460. T_1 is the hot temperature and T_2 is the cold temperature. It is quite apparent that the closer the temperatures are together the smaller will be the denominator and the larger will be the cop. With a cold temperature of 18 deg. and a hot temperature of 50 deg. the cop. is approximately 15, that is, each B.t.u. put into the compressor as mechanical work will pump 15 B.t.u. from the cold to the hot body. Unfortunately practice with the working temperatures in an ice plant is far from theoretical. To show how the cop. varies with the temperatures, the

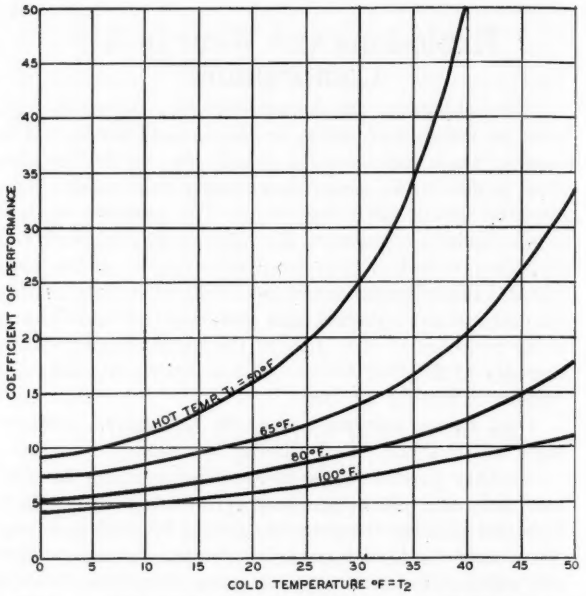


FIG. 2. VARIATION OF THEORETICAL COEFFICIENT OF PERFORMANCE WITH CHANGES IN TEMPERATURE

chart Fig. 2 has been drawn for several common temperates.

When this arrangement is used for heating the method is simple. The expansion coils are placed outdoors instead of in a cold storage room and we take heat out of the air and transfer it over to the condenser where it is taken up by the cooling water and instead of losing this heat to the air again in a cooling tower the warmed water is used for heating or process work. You had an article on panel warming in the May 15, 1930, issue and the system works well with this or rather it should because the water temperature is comparatively low. This heat pump has actually been used in some installation in England, I understand, but I have not been able to find out where. There is also said to be an installation in Italy.

Unfortunately, practically all the heat we need must be at a temperature of 100 deg. or over and when the mechanical efficiencies of the machines are considered and the cost calculated, the most of the theoretical savings is balanced so that except under exceptional conditions it will probably never be of much use. At the same time it is something that the engineer should know about because like a steam compressor some condition may arise where it will save a lot of money.

Brooklyn, N. Y. P. F. ROGERS.

Questions and Answers

Power for Conveyor Motor

WHAT POWER electric motor is needed to operate an ice house run conveyor as shown on the sketch and what pulley diameter and speed will be used? Chain speed will be 300 ft. a min. and six cakes of ice, weight 3000 lb., will be handled at a time.

A. With the data given, a certain amount of assumption is necessary to get a solution.

First as to the figures which can be definitely calculated with the 21-in. sprockets, to give a chain speed of 300 ft. a minute will require 54½ r.p.m. With a gear ratio of 84 to 12, this will mean that the counter-shaft will run at 381½ r.p.m. With 3000 lb. of ice on the

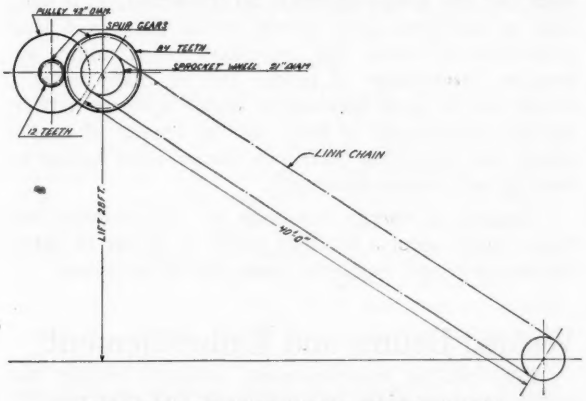


DIAGRAM OF LINK CHAIN TO HOIST ICE

chain, at 300 ft. a min., the tons capacity of the conveyor per hour would be 3000 × 300 × 60 ÷ 40, or 675 tons. This would be the rate of delivery of load which would have to be taken care of whether the conveyor was running continuously or not.

With 40 ft. between centers and a 28-ft. lift, the angle of the conveyor with horizontal would be 44½ degrees.

As to the horsepower required, L. S. Marks gives for the horsepower of a scraper type conveyor the following:

$$HP. = (AWLS \div 1000) + (BLT \div 1000)$$

where the symbols are as follows:

A and B are constants from experiment.
W is the weight of the conveyor chain per ft.
L is the length between centers of sprockets.
S is the speed in feet per minute.
T is the capacity in tons per hour.

For the angle of 44 deg. and a scraper conveyor with sliding blocks, constant A is 0.021, constant B is 0.7 for material such as ice which has a low coefficient of friction. For a chain such as you would be using, W would probably be 35, S would be 300 and the value of T we have figured out as 675; L, of course, is 40 ft.

Taking these values and working out the horsepower gives 27.7 as that needed to drive the conveyor.

Assuming efficiency of the transmitting mechanism as 90 per cent for the conveyor itself, 85 per cent for the spur gears and 80 per cent for the belting, the total efficiency from motor pulley to conveyor would be about 60 per cent. This would require that the motor power be 27.7 ÷ 0.6, or 46 hp. This is for running but it is likely that the motor will at times have to start with the conveyor loaded and recommendation is made that a 20 per cent allowance be given to take care of this which would bring this up to a 54-hp. motor. Probably a 50-hp. will serve the purpose.

If a squirrel cage a.c. motor is to be used, it would run at 1750 r.p.m. on 60 cycles, then with the 42-in. counter shaft pulley running at 382 r.p.m. and the motor pulley at 1750, diameter of the motor pulley would be 42 × 382 ÷ 1750, or 9.1 in. If we allow 10 per cent for the belt slipping, an 8-in. pulley would be used on the motor.

If a direct-current motor is used, the speed for a 50-hp. would be about 1150 r.p.m. and, by the same method, the diameter of the motor pulley diameter would figure out 14 in. With a 10 per cent allowance for slip, a pulley 12 in. in diameter would be used.

Allowances are quite liberal and it is possible that a somewhat smaller motor would do, particularly if the conveyor is to be used but a small part of the time. In that case, very likely a 40-hp. would get by, as the worst that could happen would be that it would be unable to carry the full 3000 lb. of ice.

Comparison of Steam and Water Weight

WHAT IS the relation in pounds between boiler water and steam, or if I evaporate 1000 lb. water, how many pounds of steam should I have generated? How much space does 1 lb. of steam occupy? A. W. C.

A. One pound of water will generate one pound in weight of steam; therefore, your 1000 lb. of water will generate 1000 lb. of steam.

The space which 1 lb. of steam occupies is entirely dependent upon the pressure. The higher the pressure the smaller the space which a given weight of steam will occupy. If you have a copy of a steam table you can easily find the volume that a pound of steam will occupy by looking under the heading absolute pressure, lb. per sq. in. and finding there the pressure at which you wish to determine the specific volume of a pound of steam. Follow this over to the column headed specific volume cu. ft. per lb. of steam and you will have the desired answer, that is, the specific volume of a pound of steam at atmospheric pressure, 14.7 lb. is 26.83 cu. ft.

Editorial Comment

Massed Energy for Economy

Victories, whether financial, economic or martial are generally won by concentrating resources for a massed attack. In the field of power engineering, the struggle is for economic victory over waste and loss of energy and to win requires the same strategy.

To gain from our sources of energy, coal, oil and water power, the best results requires that the problem of conserving and utilizing energy be studied with all uses, methods of saving and utilization taken into consideration, also that producers and users of energy coöperate. Requirements for producing energy at least cost and for using it to best advantage are so related that utility companies, industrial users and domestic consumers should each be interested in aiding the others to find the best solution.

Fortunately, the tendency is toward such coöperation, as shown by the increasing interconnection of utility and industrial plants to interchange energy according to plant requirements, thus bettering load factor on both central stations and individual plants and reducing investment in spare and peak load capacity. Also utilities are showing activity in aiding domestic customers to get the most possible in convenience and service from the energy they buy. It is easier to induce the householder to use more energy than to convert him to careful and efficient use but the effort to show him how should help in establishing friendly public relations and go far to prove that the utilities seek to be real servants of the public.

Ways in which massed effort can be used to advantage have been frequently pointed out. These include interconnection of networks and including individual plants as part of the system for exchange of energy, to take advantage of diversity in time requirements for power and heat, utilize the economy of large units for base load, also to make full use of the energy available at water powers, either stream flow or stored flow. Methods have been fully discussed, are well understood and their application is being increased, two notable examples being the Deepwater Station and the Conowingo development, the former for exchange of energy with industry, the latter for salvaging stream-flow power.

Details of equipment of the individual plant and the interchange of energy with the utility network must depend, of course, on the relation of power and heat demands. Some possibilities, suggested by B. F. Wood in a paper before the World Power Conference are a steel mill to take power from the network and supply waste gas to a utility-owned station for fuel. The waste gas energy would supply some 100,000,000 kw-hr. a year above the needs of the steel mill. Also in a group of packing houses, a central supply for power and steam, of size to meet maximum demands would have, a large part of the time, excess capacity which could be utilized for supplying the network "pool of power." Again W. F. Ryan in a paper before the A. S. M. E. has shown a saving of over 10 per cent in installation cost, and 19 per cent in fuel used by combining a 20,000-kw. central station with an industrial plant of 5500 kw. output and with steam demand for 600,000 lb. an hr. for process work. He cites some 140 industrial plants for 300 lb. gage or over installed in 5 yr., which probably could interchange energy to good advantage with a network system.

Massing the resources, for both power and heat generation will nearly always result in economies. The important points are that a careful study of power and heat requirements be made, the system of equipment and operation planned to meet these requirements and the payment rates for energy interchanged fixed on a basis fair and advantageous to all concerned. It is likely that an unbiased study would reveal that, in a large proportion of cases, the individual plant might well practice interchange of power and, in many cases, it would also be good economy to install a steam network for the interchange of heat and for supply of heat to plants now operating their own low-pressure boilers for heating and process work only.

Massing of energy resources to win victories over waste would seem a strategy likely to go far in future development and worthy of most careful attention.

Welded Drums and Embrittlement

Research on embrittlement indicates clearly that several factors must be considered and that two definite conditions must be present simultaneously in order to produce this type of failure in boiler plate. The metal must be highly stressed, probably to the vicinity of the yield point and the steel must be in contact with a concentrated solution of sodium hydroxide. Portions of drums overstressed but in contact with soft boiler water are not endangered by embrittlement; neither are normally stressed sections in contact with highly concentrated solutions, as for instance in joints between plates.

Hammer welding or fusion welding eliminates the majority, in a good weld probably all, of the crevices where concentration can take place, so that, even though the metal might be highly stressed, the absence of concentrated caustic solutions would undoubtedly prevent embrittlement.

There remains, however, the danger of embrittlement around tube ends, where high stresses set up during rolling leave the metal in a condition susceptible to embrittlement because the boiler water concentrates in the small capillary spaces between the tube and drum. Embrittlement of this kind has been experienced and must be watched so that welded drums will not remove entirely the necessity for rigid conditioning and control of boiler water.

Off Duty

If old Mother Earth has any sense of modesty she must feel terribly outraged these days, for the way in which "snooty" scientists have been violating her privacy lately is nothing short of scandalous. Not content with trampling all over her surface and poking into her past, they now have taken to invading her most private domains; going far into her oceans and high into her stratosphere.

Now, every well-behaved, modest lady knows, one's stratosphere is something she doesn't want a crowd of brazen scientists to be snooping around in, so Mother Earth, being a well behaved dame, wears her stratosphere where she thought surely it would be free from profanation by scientific upstarts. But the old lady is not as young as she used to be and the green mold which affects her wrinkled skin in her old age has given rise to a species of parasites which seem to become increasingly audacious each year. Time was, when she was a fresh young maiden—when her surface was warm and radiant—when no such disease as "life" infected her epidermis, but today when she is beset with the years and the blush of youth has vanished, these living organisms which swarm over her surface, more and more add to her worries. Even the outer reaches of her atmosphere is not free from them.

Only several days ago, two German scientists, Professor Auguste Piccard and his assistant Charles Kipfer, sealed in an air-tight aluminum sphere, succeeded in ascending to a height of ten miles above the earth's surface—well into that region known as the stratosphere. And whether Mother Earth likes it or not, it appears that scientists will continue to amaze their fellow beings with feats of this kind until there remains absolutely no corner on the planet's surface where man does not travel. Already the field of possibilities is narrowing rapidly.

This last feat of ascending ten miles into a region where, without artificial means, no man could live is most amazing and it truly astonished the world. And yet, this was only slightly more thrilling than Wm. Beebe's descent 1400 ft. below the surface of the Atlantic ocean last year. Think of the nerve of it! Right smack down into Davey Jones' locker went this intrepid marine explorer, sealed in a two-ton, air-tight, cast-iron ball, which he called the "Bathysphere." Down he went, a full quarter of a mile, into a region of the earth's surface where no human being had ever been before, a region where the pressure was over 600 lb. per sq. in.

Amazing? Indeed, nothing short of it, but again this is but child's play compared to the proposed voyage under the ice to the north pole in a submarine by Sir Hubert Wilkins. Even as we write, the final preparations for this daring undertaking are being made.

Off hand, this venture may appear as foolhardy as any that has ever been undertaken and it is so regarded by the general public. And until Sir Hubert returns successfully this opinion will prevail—after that he will be acclaimed the world's most skillful explorer.

Thus it is, in every instance; just a few days ago, when the fate of Piccard and Kipfer was still in the balance, before their balloon had landed, the feat was regarded as a foolish venture, but the instant the news of the successful landing was flashed around the world, their expedition was applauded one of the marvels of modern science.

This attitude on the part of the public perhaps is justified for the public is without means of differentiating between a mere foolish adventure and a venture founded on scientific possibilities and safeguarded by sound scientific principles. The proposed voyage of Wilkins, for instance falls into the latter class. Wilkins' "Nautilus" appropriately named after its famous predecessor in fiction, the "Nautilus" of Jules Verne's "Twenty Thousand Leagues Under the Sea" is one of the most carefully thought-out devices ever constructed.

Equipped with every conceivable safeguard and protective measure known to science, this remarkable submarine has everything in its favor for negotiating the trip across the top of the world successfully. This 20th century Nautilus will go a-skiing on her back, sliding along upon the under surface, by means of a sled deck and a guide wheel, pneumatically controlled which presses against the ice at the end of a trolley arm. Because of her slight negative bouyancy she will glide according to the contour of the ice ceiling. She also is fitted with ice boring apparatus, capable of drilling upward through the ice so that a telescopic conning tower can be raised enabling men to climb through it to the surface of the ice. Another important part of her gear is a collapsible bowsprit which is intended to absorb the shock of collision with undetected obstacles. A folding periscope, lying flat beside the sled deck while the vessel is traveling under water and ice, can be erected for observation when open water is encountered.

These are a few of the more unusual devices, but in addition, the ship is provided with a score of other equipments; indeed, this vessel would bring joy to Jules Verne's heart could he return to earth to see it today so completely does it fulfill his dream of 1881. Remarkable as Verne's imagination was, however, it was inadequate to cope with the realities of 1931. For while this ship has the electric cooking and heating devices, the distilled water equipment and even the electric clock described by Verne, even this brilliant Frenchman was unable to foresee, the electric refrigerator, the sun lamp and that marvel of marvels, the radio with which Wilkins' Nautilus is equipped.

So the adventurous enterprise will proceed. Once it was done in a stirring tale of scientific fiction; this summer it is to be attempted in real life. From Spitzbergen to Bering Strait, via the Pole, in 42 days, that is the schedule. And whether Mother Earth likes this further violation of her privacy or not, we hope they succeed. A bon voyage to Sir Hubert. Our best wishes to his success.

AN ENGINEER'S duties should comprise plans for installing new equipment to meet expected conditions and changes in the operating procedure of existing equipment so that its maximum efficiency is obtained.

WHEN OPERATING two or more units in parallel, it is not always advisable to divide the loads in proportion to their capacities. An allocation of load schedule should be made up from the efficiency curves of the machines.

Power Plant Engineering Developments and News

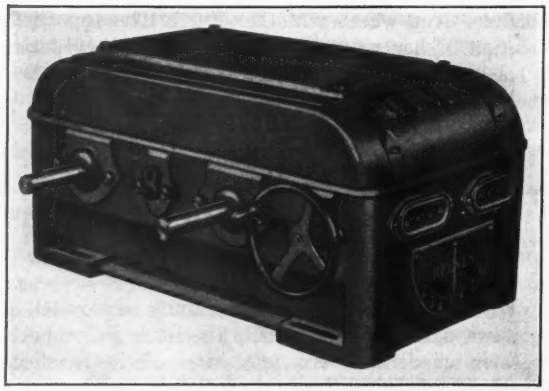
Enclosed Reeves Transmission

ENCLOSED DESIGN Variable Speed Transmission has been recently announced by Reeves Pulley Co., Columbus, Ind. In this new unit, the standard internal operating parts of the transmission are totally enclosed in a compact, neat and symmetrical cast-iron case. The enclosure is designed to meet all modern requirements for attractive lines in industrial equipment and is of practical design and sturdy construction. It affords complete protection in all machine applications where the operating parts of the transmission must be guarded from water, live steam, chemical fumes or abrasives.

Easy access to the internal operating parts is provided by U-shaped recesses in the sides of the bottom section of the case which permit the removal, as a unit, of the operating parts, including the bearings of the two shafts as well as the shifting and belt tightening screw.

Complete lubrication of all bearings is accomplished through force feed fittings, located in two recessed panels at one end of the transmission. From these eight fittings, rigid copper tubes lead to the four radial shaft bearings and flexible copper tubes lead to the four thrust bearings fitting around the disc hubs. By means of openings from the thrust bearings, the lubricant is also forced into the spiral grooves of the disc hub bores, to lubricate the disc hubs, shafts and driving keys.

The new enclosed design is built in six sizes, covering requirements from fractional to 10 hp. in all speed ranges. It is designed to be mounted on floor, ceiling or in vertical position. The cover section accommodates adjustable motor rails and cross rails on which a complete motor unit or auxiliary countershaft unit may be mounted for varying requirements of machine-speed control.



ENCLOSED DESIGN REEVES TRANSMISSION

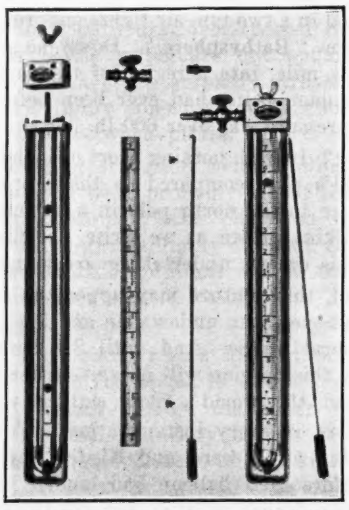
Manometer Easily Disassembled for Cleaning

NEW DESIGN of U-tube manometers and flow meters for measuring pressure or flow of any liquid, steam or gas, is now on the market. The distinctive feature of these instruments is that they are designed to be removed from the line for cleaning or replacement, without unscrewing the pipe connections. They are manufactured by the Meriam Co., Cleveland, Ohio.

The instruments consist of two separable parts: the head, permanently attached by the pipe connectors to the line and the housing which carries the scale and tube and which may be readily removed from the head by unscrewing a convenient wing nut. The top of the housing carries a threaded column which passes completely through the head-casting and serves to carry the wing nut.

The wing nut engages with a vertical stud in the housing, and serves to hold the two parts of the instrument in place. The rubber gaskets which keep the ends of the U-tubes pressure-tight fit into tapered holes in the head communicating with the pipe-line, and thus a moderate tension of the wing nut exerts ample compressive force on the gaskets to prevent all leakage.

The instruments are designed to withstand all line pressures up to 100 lb. per sq. in., and may be supplied to measure any differential pressures up to approximately 50 lb. per sq. in. or flows giving an equivalent differential.

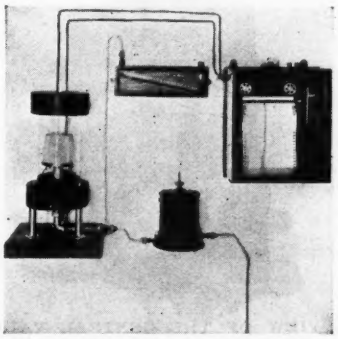


MANOMETER CONSTRUCTION FOR REMOVAL FROM LINE WITHOUT BREAKING PIPE CONNECTIONS

Instrument to Measure and Control Heating Effect of Gases

INSTRUMENT for checking the heating effect of fuel gas has been developed by the Brown Instrument Co., Philadelphia. The new instrument, which is called the Brown flame analyzer, can be supplied to measure, record and automatically control the heating effect of any gas. This instrument is designed to enable gas companies, industrial plants using producer gas and the many new plants supplying butane gas to small communities to check and regulate the quality of their gas output with special reference to heating effect.

In many industrial processes the Brown gas analyzer, particularly in its automatic control type, is designed materially to aid production. There are a great number of cases in industry where the heating effectiveness of gas fuel is vital in manufacturing processes where great sensitivity to changes in the rate of heat propagation are carried on. Such an example, for instance, is a lamp factory.



FLAME ANALYZER WITH RECORDER AND PRESSURE REGULATOR

The accompanying illustration shows the Brown flame analyzer, together with the recording instrument and a pressure governor and gage controlling the flow of gas through the analyzer.

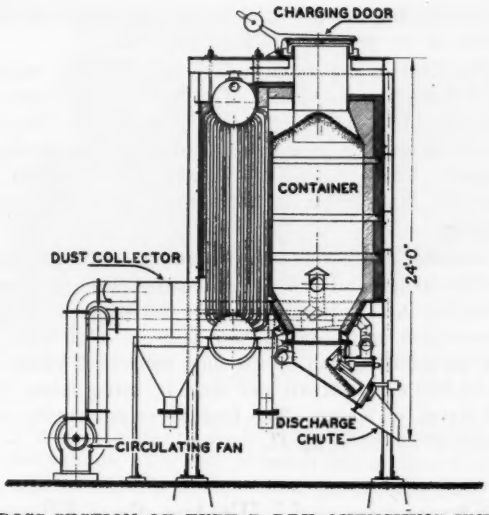
Dry Quenching Unit

NEW TYPE OF UNIT for the dry quenching of coke has been developed by the Dry Quenching Equipment Corp., New York City, for use in coal gas plants where the quantity of coke produced per day is relatively small.

This unit, designated as Type B, is designed to meet the need for a small, simply constructed, self-contained quenching unit, automatically controlled and representing a low initial expenditure that justifies its installation. It is readily adaptable to plants producing 20 to 80 t. of coke per day with charges up to 2500 lb. of coke, as it requires very little ground space and relatively small alterations to fit it into existing equipment.

This unit consists essentially of a brick lined contained and a water tube boiler of the bent tube type, both enclosed in a steel plate, gas tight housing built integral with the main supporting members.

The container has a capacity equivalent to a number of charges of coke. Prior to placing a charge of coke in the container, an equivalent quantity is discharged, hence the container is never emptied and the hot charge falls only a relatively small distance.

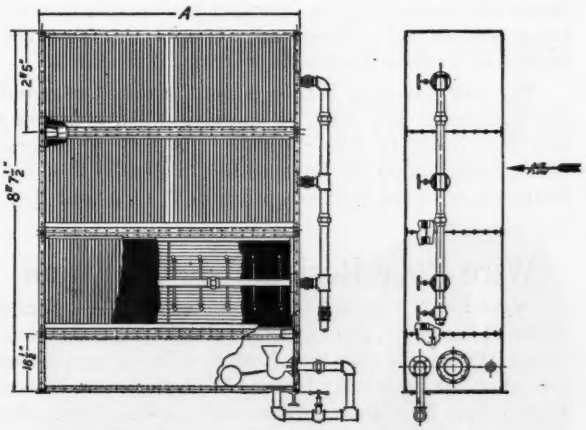


CROSS-SECTION OF TYPE B DRY QUENCHING UNIT

The unit is readily adapted to any type of coke conveying system. It is designed to produce approximately 950 lb. of steam per ton of coke cooled for a power consumption of less than 3 kw-hr. per ton.

Filticooler for Filtering and Cooling Air

DESIGNED to filter, wash, cool, humidify and dehumidify air, all in one piece of equipment, the Filticooler shown here has recently been developed by B. F. Sturtevant Co., Inc., Hyde Park, Boston, Mass. It is designed for compactness and is built in sections or units to be combined in one, two or three sections according to the conditions.



THREE-SECTION FILTICOOLER UNIT

Each single section consists of two vertical eliminators, with two removable filters inside them, and a water spray inside the filters spraying against the air flow. The design is such that the fan can be mounted close to

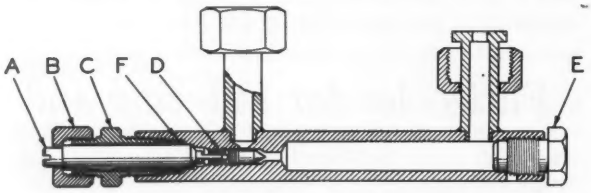
the unit to save duct work, because the eliminators are divided in the middle and face both ways.

The unit is designed for lowest possible resistance to air flow; the resistance of a No. 3 single unit handling 500 c.f.m. is 0.74 in. water, it is stated. The filters also act as a fire screen when the fan is shut down, it is claimed. These filters are continuously flushed with water by the sprays, to wash away dirt and prevent clogging.

Automatic control devices can be easily applied to the Filticooler and the parts are designed to be easily removable and accessible. The illustration shows a three-section unit; each section is 29 in. high and 28 in. deep in the direction of air flow capacities range from 300 to 500 c.f.m. of air per section, using from 12.1 to 88.8 g.p.m. of water. The face areas per section range from 3.16 to 22.65 sq. ft.

Damping U-Tube for Flow Meters

DAMPING U-TUBE has been perfected recently by the Foxboro Co. for use on all its new style flow meters and flow controllers. This U-tube is made to be adjusted for proper damping while the instrument is in



DAMPING U-TUBE FOR FLOW METERS

operation, to obviate need of shutting the pressure off or taking the instrument apart in order to make this adjustment.

In the illustration, A is a screwdriver which is fitted to the end of needle valve D. By turning A, adjustments can be made in the damping without the mercury being forced out. These adjustments can be made minute or large as conditions warrant, it is stated.

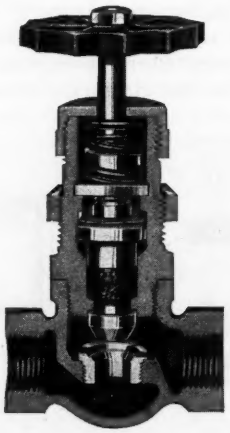
The new damping U-tube is not furnished as standard equipment but must be specified when ordering a new flow meter or flow controller. It may be ordered for installatlion on all Foxboro flow meters or flow controllers now in the field except types T, C, A and B.

Wire Rope Resistant to Corrosion

WIRE ROPE, designed for use under destructive influences of corrosive fumes, acids, alkalis, salts and high temperatures and known as Korodless, has recently been placed on the market by Hazard Wire Rope Co., Wilkes-Barre, Pa. This rope is made of chrome-nickel alloy steel wire and as it is pre-formed, it is stated to be free from internal stress. It is designed to be flexible and to operate safely in temperatures as high as 1650 deg. F. The strands and wires are helically shaped to the exact form they assume in the rope structure, in order to eliminate internal stress and allow the individual wires to lie side by side without undue internal friction. It is not necessary to seize the end, it is claimed, because strands and wires lie naturally in position.

Self-Grinding Valves and Gage Cocks

ESPECIALLY ADAPTED to conditions where scale, sediment and other solid matter are contained in the fluid being handled the new Perfection self-grinding valves and gage cocks of the Central Valve Mfg. Co., 231 East 95th St., Chicago, Ill., is offered for service where these conditions are found. This is usually in water glass drains, water column drains, gage cocks,



SECTIONAL VIEW OF THE CENTRAL VALVE MFG. CO. PERFECTION VALVES

drips, blowoff and other lines where impurities in the fluid deposit on the valve seat, resulting in improper valve seating.

The mechanical action involved in the operation of these valves and gage cocks results in a clean and smoothly ground valve seat at all times. As the stem comes to a seat in the body, the threaded section of the stem being engaged with the threads in the spring block, the latter moves upwards on the stem against a short spring. The presence of this spring against the block holds the valve to its seat.

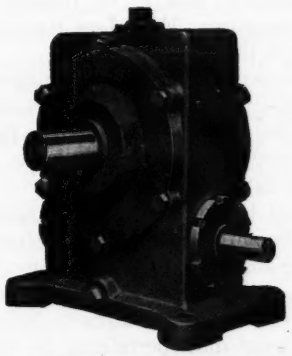
It is not necessary to run the stem completely down to a stop each time in closing. Simply close the valve sufficiently to insure a tight joint, and when scale or sediment is encountered, or when the valve begins to drip, rotate stem back and forth with spring pressure on the seat until any scale or dirt is pulverized and blown out, and the seat is ground to a tight joint.

A shoulder on the head of the stem makes a tight joint on the inside face of the bonnet when in wide open position, allowing for repacking under pressure in both closed and wide open position. This valve is made in both the 150-lb. and the 300-lb. pressures, with both integral and removable seats in sizes from ¼ to 2 in. The removable seat for the 150-lb. valve is made of nickel bronze and the seat for the 300-lb. valve of genuine Monel metal, both of which can be renewed or refaced if necessary.

Worm Gear Reducers for Small Motor Drives

SERIES OF THREE small worm gear speed reducers for small electric motor drives, up to seven horsepower capacity, has been developed by the W. A. Jones Foundry & Machine Co., Chicago, Ill.

These small reducers are almost identical with the heavy-duty Jones Worm Gear Speed Reducers except in size. The worm is made from a low carbon, nickel steel forging that is hardened to increase strength and wearing qualities and to provide for a low coefficient of friction. The wheel is made of a special nickel phosphor bronze alloy. The gear blank is dry sand cast and chilled, producing a casting of exceptional strength and load carrying capacity with a minimum of friction. The teeth are generated to a very high degree of accuracy by specially designed hobs. The gear shaft, a high carbon steel forging, extends out on both sides of the housing so that machines can be driven from right or left-hand side or both. A metal cap, or shaft guard, covers one shaft and is easily removed. Both the gear shaft and the worm shaft are mounted on Timken roller bearings.



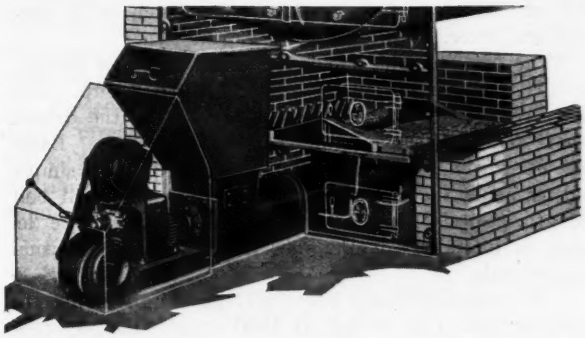
SMALL WORM GEAR REDUCER

New Screw Feed Underfeed Stoker

AUTOMATIC IN OPERATION and made in sizes to suit boilers up to 250 hp., the Big Chief Underfeed Stoker of the Marion Machine, Foundry & Supply Co., Marion, Ind., is designed to burn the cheaper sizes of free burning bituminous coal equally as well as high grade fuel.

Principal features of this stoker are the retort, tuyeres, dump grates, conveyor screw, transmission, fan, motor, control, hopper and machinery casing. The retort is heavy cast iron, connected to the barrel. Tuyeres are interchangeable, easily replaced and they distribute the air to all parts of the fire bed. A narrow section of rocking and dumping grates is located on each side of the retort to dump the ash and clinkers into the ashpit. The conveyor screw is made of cast steel with a Timken roller thrust bearing. The hopper is ⅛-in. steel plate of ample capacity.

A three-speed, similar to the automobile type, transmission is used. All gears are heat-treated steel running in grease. Timken Roller and Hyatt Bearings are used throughout. The transmission has a neutral point which allows the fan to run when not feeding coal. A ball-bearing Sirocco type fan supplies the air which is controlled by a damper placed in the air tunnel under the conveyor screw. The ball-bearing, constant-speed, electric motor used for power is mounted on an adjustable base so slack in the drive belts can easily be taken up. This drive consists of two endless V belts which give a positive and silent drive.



BIG CHIEF STOKER OF THE MARION MACHINE, FOUNDRY & SUPPLY CO.

Motor, transmission and fan are closely assembled to conserve space and all machinery is completely housed to protect it from dirt. Each stoker is furnished with an automatic pressure or temperature control which automatically starts and stops the motor to take care of load fluctuations.

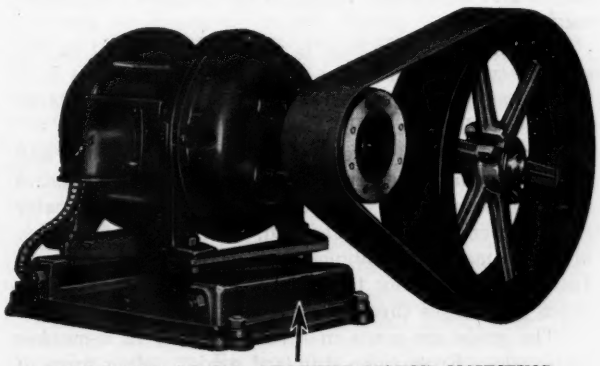
Short-Center Flat Belt Drive

INTRODUCTION of the Rockwood short-center flat belt drive, now available in stock drives from 1 to 50 hp., has been announced by The Rockwood Manufacturing Co., Indianapolis, Ind. (Division of General Fibre Products, Inc.).

The drive comprises a motor base, two pulleys and a flat leather belt. The stock drives are designed for polyphase 60-cycle a.c. motors of any make.

In this drive, the motor is mounted on a free-swinging pivot.

Automatically the force of gravity—the weight of the motor—is applied to maintain uniform belt tension at all times. The correct belt tension, once established



ROCKWOOD DRIVE, SHOWING MOTOR MOUNTING

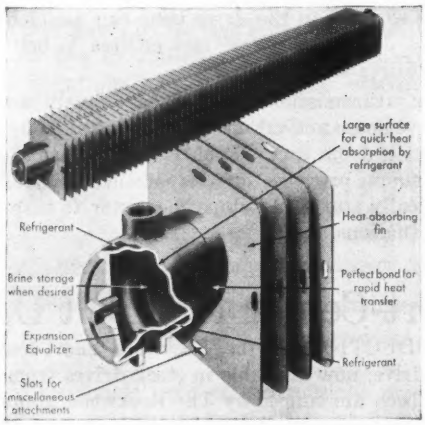
for any drive, is unchanged by belt stretch or by centrifugal force.

The base may be mounted on floor, wall or ceiling, to drive a single machine or a line-shaft group. The only restriction for any application is that the driven shaft shall not be lower than the motor shaft. Bases are of sturdy, all-metal construction, and provide simple adjustments for motor size, pulley alinement and belt length. Special length belts are not required. The design is intended to eliminate the need for the usual motor rails.

Six standard bases cover all size requirements for motors from 1 to 50 hp. at 1800 r.p.m. Larger sizes, and special mountings for machinery builders, are made to order.

Hydro-Thermal Grids

HYDRO-THERMAL GRIDS designed for use as an improvement over cooling coils in mechanical refrigerating systems are announced as a new product of the American Engineering Co., Philadelphia, Pa.



DETAILS OF THE HYDRO-THERMAL GRID

In these grids maximum heat-absorbing surface is obtained by means of steel fins with broad flanges forced upon a steel tube by hydraulic pressure. Because of the large area of these fins, it is claimed that the grids can be operated at temperatures only a few degrees below those desired to be maintained in the refrigerator and that, as a result, they do not gather the accumulations of frost that collect on cooling coils. With grids it is not necessary to shut down for periodic defrosting, it is stated, and mechanical refrigeration becomes truly automatic.

Within the outer tube is a second tube and in the space between them is the refrigerant, spread out in a thin layer for efficient heat-absorption from the large surface of the outer tube.

The refrigerant enters at one end of the tube and the heat-laden gas escapes at the other end. In no case is the gas-travel through the cooling element greater than the length of a single grid, even though a number of grids may be combined to form the cooling unit. Instead of following the windings of a coil, the heat-laden gas flashes through these grids.

The grids are made in three sizes and in a number of lengths. From these standard grids, cooling units of any size and shape can be readily assembled with standard fittings and installed without special engineering.

Hydro-Thermal Grids are strongly made, with the fins held rigidly in alinement by their broad flanges, which fit very tightly on the outer tube. The ends of the tubes are welded and the entire grid is hot galvanized. All-steel construction is used to prevent electrolytic action between the parts and to avoid any separation of the tube and fins with temperature changes. Hydro-Thermal Grids are intended to be used with any ammonia or methyl chloride refrigerating system and are applicable to refrigerators, coolers, room cooling, display cases, frozen food cabinets.

Stoker Manufacturers Meet

AT THE ANNUAL meeting of the Stoker Manufacturers Association in New York City on May 15, Joseph G. Worker, of the American Engineering Co., was reëlected president; R. C. Goddard, of Combustioneer, Inc., was elected vice-president and F. H. Daniels of the Riley Stoker Corp., treasurer. F. R. Low was elected an honorary member of the Association.

Mr. Worker reported to the Association that stoker sales were holding up to the 1930 level, sales of mechanical stokers in the United States for the first quarter of 1931 being exactly 100 per cent of the sales for the first quarter of 1929.

It was noted that the Association should serve the public more efficiently by further development of stokers for burning coal in the home. The work of the Committee of Ten, composed of representatives of national organizations who are coöperating to collect and interchange educational data pertaining to the burning of coal of both large and household stokers, was endorsed. The purpose of this committee is to coördinate the activities of the ten organizations to promote heat satisfaction with solid fuels.

The Executive Committee adopted the recommended setting heights for heating boilers equipped with mechanical stokers, prepared by the Mid-West Stoker Association, as a guide for architects and consulting engineers in determining the headroom requirements for heating plants.

It was decided to publish a revised edition of the Condensed Catalog covering all types of stokers manufactured by member companies. Incorporated in this catalog will be a new handbook of engineering data relating to stokers.

The meeting was attended by representatives of the following companies: American Engineering Co., Philadelphia, Pa.; Auburn Stoker Corp., Auburn, Ind.; Babcock & Wilcox Co., New York City; Burke Engineering Co., Chicago, Ill.; Combustioneer, Inc., Goshen, Ind.; Combustion Engineering Corp., New York City; Detroit Stoker Co., Detroit, Mich.; Flynn & Emrich Co., Baltimore, Md.; Illinois Stoker Co., Alton, Ill.; Laclede Stoker Co., St. Louis, Mo.; Riley Stoker Corp., Worcester, Mass.; Westinghouse Electric & Mfg. Co., Philadelphia, Pa.; Iron Fireman Mfg. Co., Portland, Ore. Two of these companies, Combustioneer, Inc. and Iron Fireman Mfg. Co., were admitted to the Association during the past year.

The Fall meeting will be held in Atlantic City in October.

Stevens Institute Announces Vocational Guidance Camp for Boys

STEVENS INSTITUTE OF TECHNOLOGY announces that its Engineering Camp in northern New Jersey will be used for two weeks this summer, August 15 to August 29, as the scene of an experiment in vocational guidance for boys just completing the third year in their high school or preparatory school course. Principals and headmasters have been invited by the college to present the names of students who are interested or who think they are interested in engineering. The college will open the camp to them and will provide a two weeks' program on the subject of the engineering profession and its functions. Applications for admission should be sent to the President's Office, Stevens Institute of Technology, Hoboken, New Jersey. In a letter outlining plans for the camp period, President Harvey N. Davis gave the following summary of the program:

"We propose, first, to give them a thoroughly good time in the open, second, to tell them by lectures, posters, and movies what engineering in general is all about, third, to give them some experience in a simple kind of engineering by a few hours a day of field work in elementary surveying, and fourth, to give each boy individually the best guidance we know how to give in choosing between an engineering and a liberal arts college."

President Davis suggests that an introduction to engineering is appropriate not only for the boy who seems to have the qualifications for an engineering career but for a generation that must find their places in a "Machine age."

Men actively engaged in engineering will be brought to camp to tell the boys about electrical, mechanical, civil, chemical and industrial engineering—of what each consists and the types of work involved, what opportunities exist and some of the problems with which an engineer is confronted. Among those who will tell the story of engineering to the boys will be President Harvey N. Davis of Stevens Institute of Technology, Dean Dexter S. Kimball of Cornell University, Professor A. G. Christie of Johns Hopkins University, Roy V. Wright, President of the American Society of Mechanical Engineers, John Mills of the Bell Research Laboratories, Rear Admiral Frederic R. Harris, E. P. Warner, former Assistant Secretary of the Navy for Aviation, W. R. Whitney of the General Electric Co., Stephen F. Voorhees, of Voorhees, Gmelin & Walker, architects, and R. C. Post of Post & McCord.

These men and others of prominence in engineering fields will define as graphically and completely as possible what it means to be an engineer dealing with aeronautics, power, communication, railways, building construction, work along the water front on docks, yards, and harbors. They will give the boys insight into research, machine design, and other possible lines of engineering work.

In addition to the information that will be furnished through lectures and motion pictures, the boys will have an opportunity to sample some of the work that an engineer must do. Three or four hours each day will be devoted to surveying under the supervision of men from the Stevens faculty and their assistants.

From the psychological standpoint, all possible guidance and analysis to individual aptitudes will be given each boy. Johnson O'Connor will give his individual aptitude tests; Walter Van Dyke Bingham, director of the Personnel Research Laboratory and Adam Leroy Jones, director of admissions in Columbia University, will be consulted in helping the boys to make intelligent decisions as to the best type of vocation for each individual.

Death of Charles Day

CHARLES DAY, chairman of the board of Day & Zimmerman, Inc., Philadelphia, Pa., and director in several other corporations, died on May 10 at the University Hospital in Philadelphia after a 10-day illness.

He was born in Philadelphia in 1879 and graduated at the University of Pennsylvania with an engineering degree in 1899. Three years later he established the engineering firm of Dodge & Day, specializing in management and construction work. In 1911 the company became Day & Zimmerman and Mr. Day was its president until 1926, when he became chairman of the Board.

During the World War Mr. Day was a trustee of the Emergency Fleet Corp. and served on many government committees. He was a member of the American Society of Mechanical Engineers, American Institute of Electrical Engineers and of the Engineers' Clubs of New York and Philadelphia. He was also a member of the Board of Managers of the Franklin Institute and trustee of the University of Pennsylvania. He was author of articles on industrial management and of a book entitled Industrial Plants.

News Notes

F. H. MOREHEAD, chief engineer of Walworth Co., Boston, Mass., was elected engineering vice president of the company at a recent meeting of the directors. Mr. Morehead, a graduate of the University of Missouri, was employed for several years by the American Steel and Wire Co., and later was with the Kewanee Private Utilities Co. In 1905 he went to the Western Tube Co. This plant was subsequently acquired by Walworth Co. Mr. Morehead was made manager of Walworth Boston Works in 1921 and later became chief engineer of the company.

J. F. OWENS was elected president of Oklahoma Gas and Electric Co. at a recent meeting of the board of directors in Oklahoma City, it has been announced by John J. O'Brien, president, Standard Gas and Electric Co. Mr. Owens has been vice president and general manager of Oklahoma Gas and Electric Co. since 1918. The office of president has been held by Mr. O'Brien, who as president of Byllesby Engineering and Management Corporation and Standard Gas and Electric Co. has also served as president of most of the subsidiary and affiliated companies comprising the Standard Gas and Electric Co. system. The board of directors also elected as officers of Oklahoma Gas and Electric Co., W. R. Emerson, vice president and treasurer; Frank J. Meyer, vice president in charge of operation; George Ade Davis, vice president in charge of public relations and B. M. Lester, secretary of the company.

READING IRON CO., Reading, Pa., announces that effective April 1, J. K. Aimer was appointed assistant general manager of sales, with offices at 230 Park Avenue, New York. W. S. Shiffer was appointed assistant to general manager of sales. R. I. Fretz has been transferred from the Reading district and will assume charge of the Pittsburgh district in place of Wyman Howells, who will now direct the activities of the Reading district.

The following appointments were effective April 1. Harry L. Bialock is associated with the St. Louis district under the direction of J. L. Jacobson, district sales representative. L. C. Hartzell is under the direction of R. W. Thompson, Reading,

in the promotion of nipple business. Effective May 1, Geo. D. Smith, was appointed railroad salesman operating under the direction of J. K. Aimer. For the present Mr. Smith's activities will be confined to the East. E. S. Moorehead was appointed to the Pittsburgh district under the direction of R. I. Fretz, district sales representative.

L. W. MERCER, vice president and general manager, Square D Co. Detroit, Mich., has announced the establishment of the Power Filter Division of the Square D Co. with offices and works at Detroit. M. D. Williamson will be in charge of the new division. Officials of the Diamond Electrical Mfg. Co. Ltd., of Los Angeles, Calif., affiliated with the Square D Co. recently opened the new branch factory of the Diamond Division at San Francisco. The new building is located at 130 Potrero Ave. J. J. Mitchell, former branch sales manager of the Square D Cleveland office, is now sales manager of the new Diamond San Francisco office.

AT A RECENT MEETING of the Board of Directors of the General Refractories Co., Philadelphia, Pa., Burrows Sloan was elected chairman of the board, John R. Sproul was elected president, E. A. McKelvy was elected vice president and Roger A. Hitchins was elected secretary and treasurer. All of the other officers of the Company were reappointed.

TAYLOR STOKERS were recently purchased by the New York State Department of Mental Hygiene for the Central Islip State Hospital at Long Island. Three stokers will be placed under new boilers and three under boilers from which obsolete stokers will be removed.

J. R. CROCKER has been appointed Special Western Railroad Representative for The Permutit Co. Mr. Crocker, who has been associated with the company since 1913, will have headquarters at 215 Pershing Road, Kansas City, Mo., where he has acted as district manager for a number of years. W. R. Toppan has been made Special Eastern Railroad Representative, with offices at 1132 McCormick Bldg., 332 S. Michigan Ave., Chicago.

KIELEY & MUELLER, INC., New York City, announces the appointment of Engineering Sales Co., 2831 South Parkway, Chicago, as its representative for Northern Illinois. This company is under the direction of H. E. Wheeler and H. J. Prebensen.

THE MODERN COAL BURNER, Chicago, Ill., has opened a direct factory branch at 4450 Duncan Ave., St. Louis, Mo., telephone Newsted 0135. E. S. Bremerman who has been active in sales organization work, representing the Modern Coal Burner in the St. Louis district, has been appointed district manager. The office not only will handle metropolitan St. Louis but will extend its activities over the southern and eastern part of Missouri.

PHILLIP M. WENTWORTH, for many years associated with the Stone & Webster organization in the management and supervision of electric, gas and transportation properties, has recently been elected a vice president of the Stone & Webster Service Corp. with headquarters in Boston. In 1910 Mr. Wentworth graduated from the Massachusetts Institute of Technology and immediately became associated with Stone & Webster. For 13 years he was connected with the Sierra Pacific Electric Co. at Reno, Nevada, working up to the position of assistant manager. From Nevada he was transferred to Fort Madison, Iowa, as manager of Fort Madison Electric Co. He was in turn Manager of Keokuk Electric Co., Keokuk, Iowa; Haverhill Gas Light Co., Haverhill, Mass.; Cape Breton Electric Co., Ltd., Sydney, Nova Scotia and Florida Motor Lines, Orlando, Florida. During his connection with public utilities in the Southeast he served as a director of the Southeastern Section of the National Electric Light Association.

TAYLOR STOKERS have been ordered for the municipal power plant by the City of Wyandotte, Mich. They will be equipped with the new straight line drive. Froelich and Emery Engineering Co. is the engineers. The stokers will be built by the American Engineering Co. A Taylor stoker has been selected for the new power house at Roxboro, N. C. plant of the Collins and Aikman Corporation. H. M. Wilson is the engineer for the project.

BOILER ENGINEERING CO., has moved into more spacious quarters in the new National Newark & Essex Bank Building, 744 Broad St., Newark, N. J.

AT A RECENT MEETING of the Board of Directors of the McIntosh & Seymour Corp., Auburn, N. Y., John Thomas was appointed vice president in charge of sales. Mr. Thomas is a native of Alabama, a graduate engineer and was for 10 yr. with General Electric Co., during the latter part of which period he was in charge of the Marine Section. He became general sales manager of McIntosh & Seymour Corp. in October, 1930.

THE BABCOCK & WILCOX CO. has acquired non-exclusive license under Automatic Arc-welding Co. patents.

SHARPLES SPECIALTY CO., announces the appointment of Weaver L. Marston as sales manager with headquarters at its main office, 23rd and Westmoreland Streets, Philadelphia, Pa. Joining the organization in 1926 as assistant sales manager, Mr. Marston, for the last 3 yr. has been general manager of the Pacific branches of the company with headquarters at San Francisco, Calif.

AUGUST 10 TO 25 will be held at Silver Bay on L. George, N. Y. a meeting of four industrial groups. Industrial Supervision, Plant Training, Personnel Principles and Methods, a conference of small industries, which make up some 95 per cent of the plants of the country, are included in the program. Further information can be obtained from Charles R. Towson, secretary, 347 Madison Ave., New York, N. Y.

ORDER for 750 t. of electric welded steel pipe for the City of New York has been placed with Alco Products, Inc., a division of American Locomotive Co. The pipe, which is 48-in. in diameter, will be used for extensions to the water supply system in the Bronx. It will be fabricated in the company's plant at Dunkirk, N. Y.

APPOINTMENT of Charles R. McConner as sales manager for the Clarage Fan Co., Kalamazoo, Mich., has been announced by Roland R. Ware, vice president and general manager of that organization. Mr. McConner was connected with the Clarage Fan Co. from 1920 to 1928 and was for seven years of this time branch manager of the Clarage Chicago office. Since 1928 he has been branch manager in Detroit for the Carrier-York Corp. He attended Swathmore College, and served as lieutenant of infantry during the World War.

H. A. JACKSON, President of the Chicago Pneumatic Tool Co., 6 East 44th Street, New York, announces the election as executive vice president of W. L. Lewis, who for the past year has been vice president in charge of finance of that company and was formerly assistant comptroller of the Bethlehem Steel Corp.

LUBRICATED PLUG VALVES, for oil, gas, water and other industrial service, and lubricated service cocks for gas and air are now available from Walworth Co., Boston, Mass. The addition of lubricated plug valves to the Walworth line followed the acquisition of basic patents by the company. This type of valve is designed to give all of the much desired advantages of full, direct port opening with a quarter-turn of operating handle or wrench. The valves are smooth-turning and can be throttled or opened wide at will. Tight seating is assured by the fit between plug and body and the lubricant seal, while the lubricant also prevents wear. The valves are available in practically all types and sizes and in metals suited for the services required. They are furnished for high as well as low pressures and for vacuums, suitable for air, oil, water, gasoline, gases, chemicals, hot tar, hot oils, and so on.

The successful operation of lubricated valves is dependent to a great extent upon their proper lubrication and Walworth Co. engineers have developed several kinds of lubricant for various service conditions, with reference to pipe line contents, temperatures and other factors. Long life and a minimum amount of maintenance labor are assured by use of the correct lubricant.

Walworth lubricated plug valves may be operated with ordinary monkey wrenches, although special operating handles are made and on larger sizes hand wheels are furnished. Planetary geared handles also can be furnished on certain sizes of valves.

SECOND GENERATING STATION in Oklahoma to be named after an individual was formally opened by the Oklahoma Gas & Electric Co. at Oklahoma City, May 21. It is known as the Arthur S. Huey Memorial generating station and is located on Belle Isle Lake in the northern part of the city. Officers and stockholders of the company were hosts at the dedication. The plant was thrown open to the general public May 24 and was visited by several thousand people. Arthur S. Huey, who was president of the Oklahoma Gas & Electric Co. at the time of his death in Chicago in 1924, was a pioneer in the electrical industry in Oklahoma. The company had its beginning at Enid in 1903. The next year Mr. Huey, H. M. Byllesby and others purchased the Oklahoma City electric light and power plant and for a number of years Mr. Huey was in active management of properties in the state. The Arthur S. Huey generating station was completed and put in operation the first of the present year, but was not formally opened until last week. It has a generating capacity of 30,000 kw. and is one of several large generating stations of the Oklahoma Gas & Electric Co. which serve 234 cities and towns in Oklahoma and Arkansas. J. F. Owens, Oklahoma City, recently elected president of the company, presided at the opening ceremonies.

EFFECTIVE June 1, the Atlanta, Ga., sales office of Cutler-Hammer, Inc., will be located at 133 Cone Street, N. W. on the street floor. A. C. Gibson is Manager of the Atlanta District.

Books and Catalogs

AMERICAN STANDARDS YEAR BOOK for the year 1931 has just been published by the American Standards Association, 29 West 39th St., New York City. Many important standardization projects were initiated during the past year and several new safety codes added. One hundred eighty-five standards have been approved by the Association and 178 uncompleted projects are now under way. With the five new member-bodies which have joined the association during the past year, the ASA standards council now represents 45 technical societies, trade association and federal government departments.

The yearbook emphasizes the importance of promoting industrial standardization of such a type that manufacture of the products standardized can be carried out continuously during periods of slackened purchasing with the knowledge that the products will not become quickly obsolete and that they will be assured of an ultimate market.

BOILER AND TURBINE ROOM INSTRUMENTS are discussed in publication No. 19 recently issued by the Prime Movers Committee, Engineering National Section, N.E.L.A., 420 Lexington Ave., New York.

The report presents discussions of the use of condenser leakage recorders, boiler water level records, moisture indicators, automatic coal samplers and liquid flow meter and boiler meter water temperature compensation.

A novel scheme for metering air and coal to a pulverized coal fired furnace is described under Plant Instrument Installations. Other developments include meter test boards and a chemical measuring device for feedwater treatment.

A review of the economics of instrument application is included; also, plans for instrument standardization are suggested.

FORECASTING WATER SUPPLY is the subject of N. E. L. A. publication No. 115 just issued by the Hydraulic Power Committee, National Electric Light Association, 420 Lexington Ave., New York City. This report supports two methods for analyzing records of rainfall and runoff to insure their being sufficiently accurate to be used for the study of cyclic variations in water supply. It is shown that a great many long term records are faulty but that there is still a possibility that valuable data may be derived from them. It is hoped that by applying the methods herein described, the practical value of rainfall and runoff data may be increased.

COMPLETE LINE of Toledo pipe tools and accessories is described and illustrated in catalog L, a 92-page bulletin just issued by the Toledo Pipe Threading Machine Co., Toledo, Ohio. This describes in detail pipe threading devices, pipe cutters, reamers, portable work benches, boring tools, power drives, power piping. Price lists are given for each item, details of construction are attractively illustrated, and information is given on the use of the various devices. Photographs of parts of the equipment with list prices of separate parts should prove of great interest to the users of this catalog. One of its best features is an index in the front.

MOST CORE OILS consist of a drying oil, such as linseed, china wood, or perilla oil, used as a base, compounded with some other oil or oils to lower the cost. The cheaper oils which may be used to dilute the basic oil are either semi-drying in nature, such as soya bean oil, or non-drying, such as kerosene. Rosin is also used as a diluent and a variety of combinations of oils is sometimes used to compound a core oil. Apart from the question of cost, other ingredients may be added to core oils to give greater strength to baked cores and more resistance to moisture absorption.

The investigation reported in Bulletin No. 221 of the Engineering Experiment Station of the University of Illinois was conducted to determine whether or not there is a relation between the tensile strength of cores and the physical and chemical properties of core oils used as a binder; and to determine the effect of moisture on the tensile strength of baked cores. Copies of Bulletin No. 221 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Ill.

BULLETIN No. 222 of the Engineering Experiment Station of the University of Illinois constitutes a report on the continuation of the work the results of which were published in Bulletin No. 182. The present bulletin deals with the determination of the relation between the friction factor and Reynolds' number for two sizes of standard wrought-iron pipe, with two fluids, water and calcium chloride brine, the relation between the friction factor and Reynolds' number for channels of annular cross-section, with water and commercial calcium chloride brine, and the head loss resulting from the use of standard cast-iron elbows in pipe lines conveying commercial chloride brine. Copies of Bulletin No. 222 may be obtained without charge by addressing the Engineering Experiment Station, Urbana, Ill.

IN AN ATTRACTIVELY-illustrated loose-leaf catalog recently issued, the Oster Mfg. Co. of Cleveland, Ohio, describes its complete line of pipe fittings. Among other items the catalog describes die-stocks, chip chaser die-stocks and reamers, the No. 412 Power Boy with gasoline engine drive, the Tom Thumb pipe machine and many other devices for threading pipe. This catalog also gives information concerning the Willie Williams Rapiduction and Wilco pipe machines that the company offers through its affiliation with the Williams Tool Corp.

IN A NEW 48-page illustrated bulletin entitled, Handbook of Steam Flow Measurement, L. K. Spink, manager of the Flow Meter Department of the Foxboro Co., Foxboro, Mass., presents some interesting and valuable engineering information on steam flow. For ease in understanding the calculation of steam flow, the methods used have been divided into two general classifications. The first method covers application in which the pressure and temperature conditions are almost constant; the general run of power plant applications fall into this classification. If convenience of measurements is more important than extreme accuracy, this method may also be applied to conditions of fluctuating pressures. The second method covers those applications in which the pressure varies widely and the accuracy requirements are strict. Most steam distribution and process applications, especially those in refineries, belong in this classification. Obviously, these two methods overlap and both should be carefully studied. First section discusses the orifice type meter, derivation of the commercial formula, flow meter installations, nozzles and pitot tubes, direct-reading and integrating meters, the Foxboro integrator. Then follows section two on constant pressure applications and section three on fluctuating pressure applications, with tables, charts and typical examples worked out.

SARCO THERMOSTATIC STEAM TRAPS for individual trapping systems are described in the new 8-page bulletin by Sarco Co., Inc., 183 Madison Ave., New York. This bulletin contains a general discussion of steam traps, description of the Sarco thermostatic steam trap No. 9, the heavy duty thermostatic trap, the thermostatic No. 7, with tables of dimensions and details of construction of the trap.

PARKER TUBE COUPLINGS are described and illustrated in detail, together with data on fabricating tools, combination shapes, valves, indicators and flanges, in a recent bulletin published by Parker Appliance Co., 10320 Berea Road, Cleveland, Ohio.

TIMKEN ENGINEERING JOURNAL, a 138-page loose-leaf publication in a letter-size ring binder, has just been issued by the Timken Roller Bearing Co., Canton, Ohio. This contains a great deal of engineering information on construction of roller bearings, methods of application, fitting practices and the like. The first section of the book discusses the general subject of the duty of adequate bearings, taking up the design of the Timken bearing, the roller elements, the proper function of the cage, mounting, take-up and assembly, cone and cup fittings, and the like. Bearing load calculations are given with data showing calculations of dead weight load and torque and bearing load. Then follows a section on bearing selection and the balance of the book is composed of tables of dimensions and detail drawings of the bearing itself.

DATA on Brown automatic controls for temperatures, pressures, flows, liquid levels and other process operating factors are given in a new catalog, No. 8008, issued by the Brown Instrument Co., Philadelphia, Pa. The book contains 48 pages and 45 illustrations; It tells how automatic controls help quality, workers, management, cost and sales; it shows how temperature controls are applied to many industrial processes, fired by various types of fuel.

SAUTER ELECTRIC TIME SWITCH for off-peak control is described in bulletin ZWE just published by R. W. Cramer & Co., Inc., 67 Irving Place, New York.

CABLE POWER SCRAPER for the storage of coal and other bulk material is discussed in a new bulletin by Atlas Conveyor Co., 20 South Fifteenth St., Philadelphia, Pa. The bulletin shows details of the scraper conveyor, methods of application, discusses the method of selecting size and capacity and the advantages of this method of handling.

SIMPLIFYING AND IMPROVING MACHINE DESIGN is the title of a new 24-page booklet just issued by Diamond Chain & Mfg. Co., Indianapolis, Ind. The booklet, No. 104-A, shows how Diamond high-speed roller chain can be used in simplifying and improving machine design in primary and secondary drives, multi-center drives, inter-machine drives, miscellaneous mechanism, vertical shaft drives and counterweight support.

JETVEYORS, a new and improved method of pipe line steam jet ash conveying, are described in detail in a new bulletin, No. 25, just issued by the Brady Conveyor Corp., 20 W. Jackson Blvd., Chicago, Ill.

Power Plant Construction News

Calif., Los Angeles—The American Maize-Products Co., 100 East Forty-second Street, New York, plans installation of electric power equipment in proposed new plant at Los Angeles, entire project to cost over $1,000,000. A boiler plant will be built.

Calif., Oakland—The Oakland Laundry Co., 730 Twenty-ninth Street, Oakland, plans installation of electric motors and other power equipment in proposed new mechanical laundry plant, entire project to cost over $150,000. Miller & Warnecke, Financial Center Building, Oakland, are architects.

Calif., San Francisco—Edmonds Brothers, 1901 South Bruno Street, are said to be planning the installation of electric motors and other power equipment in connection with proposed rebuilding of wooden box plant, recently destroyed by fire with loss reported over $70,000.

Colo., Greeley—The Home Gas & Electric Co., Greeley, plans construction of a transmission line to Eaton and vicinity, including power substation facilities, estimated cost about $25,000. Company engineering department is in charge.

Ind., Fort Wayne—The City Council, Fort Wayne, has plans under way for an addition to municipal electric light and power station, to include installation of new boiler equipment. Froelich & Emery Engineering Co., Second National Bank Building, Toledo, Ohio, is engineer.

Kan., Newton—The Atchison, Topeka & Santa Fe Railroad Co., Topeka, Kan., plans installation of electric power equipment in new addition to rail mill and shops at Newton, to cost over $60,000. H. W. Wagner, Topeka, is division engineer.

Md., Centerville—The Common Council, Centerville, has sold a bond issue of $70,000, fund to be used for extensions and improvements in municipal electric light and power plant, including additional equipment.

Md., Cumberland—The City Council is said to be planning the installation of filtration equipment in connection with extensions and improvements in water supply system from Lake Gordon.

Mass., Cambridge—The Cambridge Water Board, Cambridge, is planning the installation of pumping machinery, filtration equipment and other power equipment in connection with an expansion and improvement program at municipal waterworks. An appropriation of $800,000 is being arranged for the project.

Mich., Marquette—The Duluth, South Shore & Atlantic Railway Co., Duluth, Minn., plans installation of electric power equipment in connection with new ore dock, storage and distributing plant at Marquette, entire project to cost over $1,500,000. Company engineering department is in charge.

Mich., Muskegon—The Board of Public Works, Muskegon, has plans under way for a new filtration plant near Bear Lake, North Muskegon, for municipal waterworks, estimated to cost about $60,000. Boulay Harrison Co., 914 Summit Street, Toledo, Ohio, is engineer.

Minn., Montevideo—The Skelly Oil Co., Plymouth Building, Minneapolis, Minn., is planning the early construction of a gas plant and system at Montevideo, reported to cost about $80,000. Company engineering department is in charge.

Minn., Willmar—Board of Trustees, State Asylum, Willmar, plan installation of power equipment, including boiler, engine, etc., in power house, and will take bids at an early date. G. M. Orr Co., Baker Building, Minneapolis, Minn., is mechanical engineer.

Neb., Clay Center—Orr Brothers, Clay Center, are said to have plans under way for a new electric light and power plant to cost about $80,000. It is expected to begin work during the summer.

Neb., North Platte—The Northwestern Public Service Co., Huron, S. D., has approved final plans for proposed new steam-operated electric power plant on the Platte River, near North Platte, where site was recently acquired, entire project reported to cost about $400,000, with transmission system. Company engineering department is in charge.

Nev., Las Vegas—H. C. Keyes, Kingman, Ariz., is at the head of a proposed company to construct and operate an artificial gas plant and system at Las Vegas, with capacity of 300,000 cu. ft. daily, to cost about $200,000, including equipment.

N. Y., Mayville—The Board of Village Trustees, Mayville, is planning extensions and improvements in light and power system, including change from 25 to 60 cycle energy. A bond issue of $30,000 is being arranged for work.

N. Y., Newark—The Board of Village Trustees, Newark, plans installation of pumping equipment and other power equipment in proposed municipal sewage disposal plant, for which a bond issue of $100,000 is being arranged.

N. Y., New York—The Diamond Match Co., 30 Church Street, plans installation of electric power equipment in proposed new plant for the manufacture of muriate of potash, chlorate of potash and kindred chemical products, the entire project to cost over $350,000. A site is being selected.

Ohio, Cleveland—Addressograph-Multigraph Corporation, 1814 East Fortieth Street, plans construction of a power plant at proposed new plant on Babbitt Road, Euclid district, for production of addressographs and other office equipment, entire project to cost close to $1,000,000. Ernest McGeorge, Inc., 3030 Euclid Avenue, Cleveland, is consulting engineer.

Ohio, Columbus—The Columbus Independent Ice Co., 31 West Mound Street, has filed plans for a one-story ice-manufacturing plant at West Fifth Avenue and Hess Street, reported to cost over $50,000, with equipment. O. F. Kaiser is president.

Okla., Chickasha—The Common Council, Chickasha, is said to be planning the installation of pumping machinery and auxiliary equipment in connection with extensions and improvements in municipal waterworks, entire project to cost over $175,000. Robert O. Bradley is engineer, in charge.

Okla., Hominy—The Common Council has plans under way for a municipal electric light and power plant to cost over $125,000, with equipment. V. V. Long & Co., Colcord Building, Oklahoma City, Okla., are consulting engineers.

Tenn., Memphis—The Board of Works, Memphis, is said to be planning an early call for bids for auxiliary machinery for municipal waterworks. Fuller & McClintock, 170 Broadway, New York, are consulting engineers.

Texas, Gladewater—The Texas Co., Houston, Texas, plans installation of pumping machinery and other power equipment in connection with proposed new pipe line in Gladewater oil district, to connect with Joiner pool line of company, entire project reported to cost over $150,000.

Texas, Waco—The Master Petroleum Co., Waco, plans installation of electric power equipment in proposed new local oil refining plant, for which site has been acquired, entire project to cost over $90,000. S. J. T. Smith is president.

Texas, Yorktown—The Central Power & Light Co., San Antonio, Tex., has approved plans for a one-story cold storage and refrigerating plant at Yorktown, reported to cost over $30,000, with equipment.

Utah, Salt Lake City—The Utah Gas & Coke Co., Salt Lake City, plans installation of compressor plants in connection with new natural gas pipe lines at Springville, Spanish Fork and vicinity, entire project to cost over $600,000. Company engineering department is in charge.

Wash., Tacoma—The Northwest Chair Co., South Tacoma Way, plans installation of motors and other electric power equipment in new two-story factory addition, entire project to cost over $65,000. Mock & Morrison, Perkins Building, Tacoma, are architects.

W. Va., Newell—The Edwin M. Knowles China Co., Newell, plans installation of electric power equipment in connection with an expansion and improvement program at pottery, entire project to cost over $200,000.

Wis., Jefferson—The Valerius Corporation, Jefferson, plans installation of electric power equipment in connection with proposed rebuilding of portion of soda fountain manufacturing plant, recently destroyed by fire with loss reported over $65,000.

Wis., Milwaukee—Ottomar H. Henschel, Consulting Engineer, 401 Commerce Bldg., Milwaukee, announces that one of the largest furniture factories in Sheboygan is having preliminary work done including plans and specifications, for the erection of a power plant. Also, a number of smaller municipalities in Wisconsin have retained Mr. Henschel for the purpose of determining the feasibility of establishing a power district in the territory involved.